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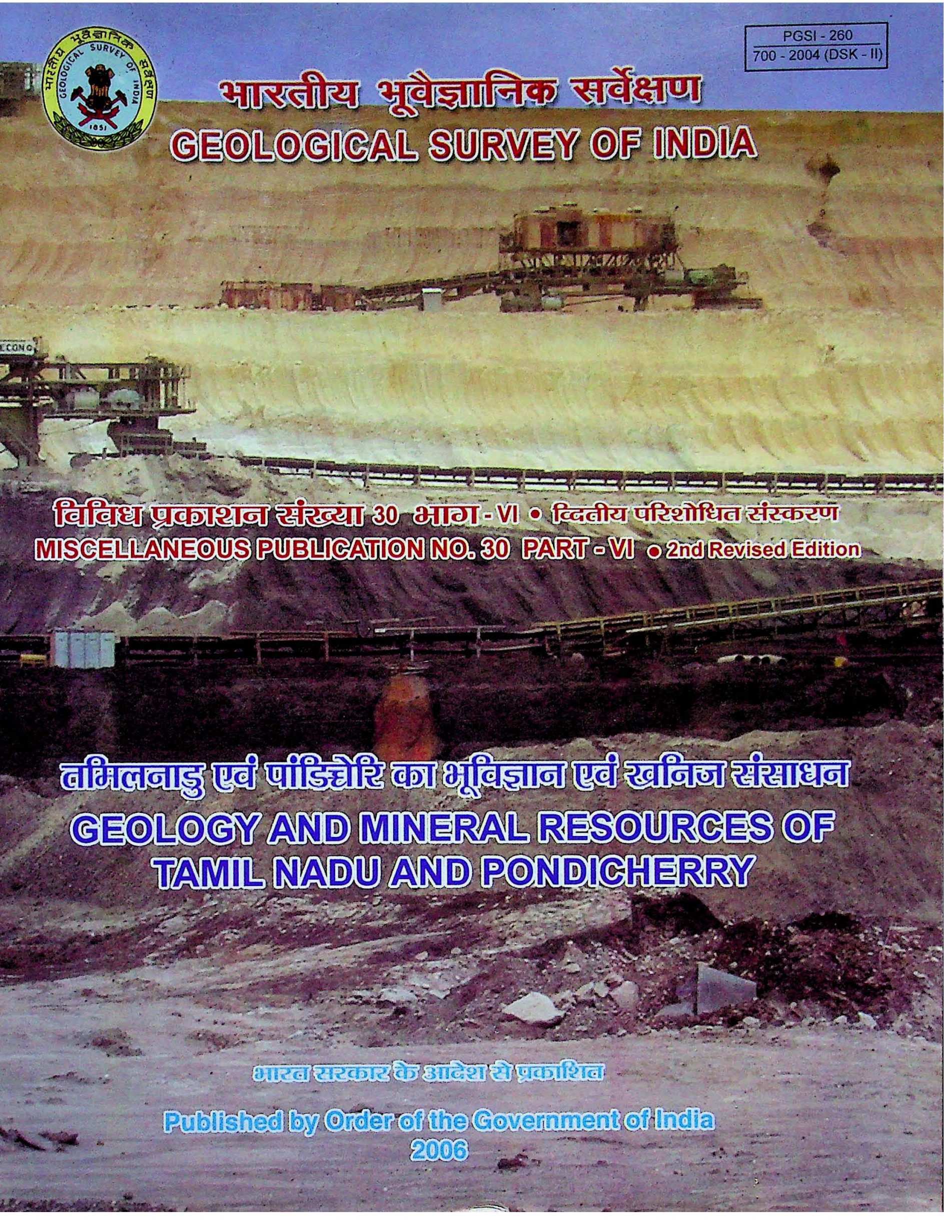
भारतीय भूवैज्ञानिक सर्वेक्षण

GEOLOGICAL SURVEY OF INDIA



विविध प्रकाशन संख्या 30 भाग - VI • द्वितीय परिशोधित संस्करण

MISCELLANEOUS PUBLICATION NO. 30 PART - VI • 2nd Revised Edition

तमिलनाडु एवं पांडिच्चेरि का भूविज्ञान एवं खनिज संसाधन

GEOLOGY AND MINERAL RESOURCES OF TAMIL NADU AND PONDICHERRY

भारत सरकार के आदेश से प्रकाशित

Published by Order of the Government of India
2006

A pink granite band traversing the amphibolite in the northeastern part of the Maruda Malai granite, Tamil Nadu.

Molybdenite chunks along the contacts of pegmatite and crystalline limestone, Vedasandur area, Tamil Nadu.

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Foreword

The series Miscellaneous Publication 30 brings out concise information on the geology and mineral resources of the states of India. The present volume, Part VI of the series, pertaining to the states of Tamil Nadu and Pondicherry is a revised and updated version of the first edition published in 1974. During the span of three decades since the first edition was published, enormous knowledge has been added in the sphere of geology of the area. The "Geological and Mineral Map of Tamil Nadu and Pondicherry" was last published in 1995 on 1:0.5 million scale along with the explanatory brochure. The Geological and Mineral Map presented in this volume is a modified and compiled version based on the 1:2 million scale Geological Map of India published in 1998.

Geological Survey of India continues its untiring work in different realms of earth science with a committed goal of 'digging the past to light the future'. In Tamil Nadu and Pondicherry, after completion of systematic geological mapping on 1:50,000 / 1:63,360 scale in 1980s, Specialised Thematic Mapping was taken up in larger scale in selected sectors. In the light of the knowledge gained from the field and laboratory research works in recent years, certain revisions were made in the stratigraphy, particularly in the Precambrian part.

Exploration carried out to find additional reserves of lignite in Neyveli and its surroundings and limestone in Ariyalur area was a great success. 'Dimension Stone' has opened up new vistas in the field of architecture. Huge deposits of different types of top class varieties of dimension stone in Tamil Nadu add substantial income to Central and State Government coffers. The discovery of primary 'Molybdenite' deposit in Harur area of Dharmapuri District has brought India in the Molybdenum map of the world and molybdenum in the mineral map of India. Efforts are on to understand the behaviour of 'Rhenium' in these molybdenum deposits. A number of 'Gold' occurrences have been located in Bhavani and Dharmapuri shear zones in the last decade.

This publication will be of great use to the professionals, students of geology and entrepreneurs.

Kolkata
17th January 2006

(P.M. Tejale)
Director General (Addl. Charge)
Geological Survey of India

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GEOLOGY AND MINERAL RESOURCES OF TAMIL NADU AND PONDICHERRY

I. INTRODUCTION

This publication is a revised version of the Miscellaneous Publication No.30 published in 1974, incorporating latest information culled through the work of GSI on various aspects of geology and mineral resources of Tamil Nadu and Pondicherry.

It is interesting to note that even before setting up of the Geological Survey Of India in 1851, the then Madras Presidency received the attention of a number of professional and amateur geologists, many of who were in the service of East India Company. After the birth of Geological Survey of India, systematic work on geology and mineral resources was taken up and pioneering work was carried out by the officers of the department. Blanford (1858) studied the geology and structure of the Nilgiri Hills. Subsequently, Blanford (1862) studied the Cretaceous rocks of South Arcot and Tiruchirapalli Districts. William King and Bruce Foote (1864) contributed to the knowledge of geology of Tiruchirapalli, Salem and South Arcot Districts. Bruce Foote (1873) carried out geological traverses in parts of Madras and North Arcot Districts. Bruce Foote (1883) studied the eastern parts of Madurai and Tirunelveli Districts with a view to examine the fringe of sedimentary formations which border the coast of Indian peninsula. In the 1870s William King examined the Wynad Gold occurrences and investigated artesian wells in Pondicherry-Cuddalore area. Holland (1893) investigated the iron ores in Salem District. Warth (1859) studied the Cretaceous sediments of South India and Middlemiss (1896) examined the Chalk (magnesite) Hills near Salem and corundum occurrences in Salem and Coimbatore Districts. The classic work of Holland (1900) on the charnockite of St.Thomas Mount and Pallavaram near Madras is well known. Subsequently, Holland (1901) contributed an article on the eleolite-syenite and corundum-syenite in Coimbatore District. Vredenburg (1907-1908) carried out studies pertaining to the age of Cuddalore Series and Matley (1928-29) investigated the Cretaceous dinosaurs of the Tiruchirapalli District.

At the advent of the 20th century, search for mineral deposits was intensified. Hayden and Hatch (1901) examined the Wynad Gold Field and the auriferous localities in the erstwhile composite Coimbatore District. Limestone deposits in Salem and other areas were investigated and detailed exploration carried out on a number of limestone occurrences had resulted in the setting up of several cement plants in the state. Krishnan investigated bauxite deposits in the Shevaroy Hills (1942) and minerals of Uttattur Stage of the Cretaceous rocks in Tiruchirapalli District (1960).

Details of the varied mineral occurrences in the state and the work carried out by the department till about the middle of this century were summarised by Krishnan in Memoir Volume No.80 of the Geological Survey of India (1951) and Aiyengar in 'Minerals of Madras State' (1964).

With the expansion of Geological Survey of India and application of multidisciplinary approach to Earth Science investigations, geological mapping and mineral exploration and assessment were

intensified. Systematic geological mapping on 1:63,360/1:50,000 scale of Tamil Nadu and Pondicherry, except the areas along the coast covered by Quaternary formations in Tamil Nadu was completed in 1980. Geological and geomorphological mapping of Quaternary sediments along the coastal tracts was commenced in 1973 and completed by the end of 1989. Second generation mapping and specialised thematic mapping in selected segments viz. Cauvery lineament, Dharmapuri Alkaline Province, Attur-Gangavalli-Kottapatti Shear zones, mapping under Mega Granite Projects, structural mapping in critical areas viz. Andipatti, Usilampatti, Madurai and Kodaikanal Hills, special programmes on coastal environment projects and integrated studies were carried out by Operation : TNP&K, GSI in collaboration with other specialised divisions of GSI, such as Engineering Geology Division and Palaeontology Division. Special studies on specific projects were also carried out by the Geological Survey of India in collaboration with the Directorate of Geology and Mines (formerly State Geology Department), Govt. of Tamil Nadu, the Madras Metropolitan Development Authority (MMDA) and the Tamil Nadu Water Supply and Drainage Board (TWAD).

Tamil Nadu, with an area of 1,30,058 sq km is situated in the SE part of the Indian peninsula between North Latitudes 08°00' and 13°30' and East Longitudes 76°15' and 80°18'. It is bounded in the east by the Bay of Bengal, in the south by the Indian Ocean, in the west by the Kerala State and Arabian Sea while in the north by Karnataka and Andhra Pradesh.

The Pondicherry and Karaikkal Districts of the Union Territory of Pondicherry encompass a total area of 492 sq km.

The different Districts of Tamil Nadu are as listed below :

1. Chennai	11. Tiruchirapalli	21. Madurai
2. Kanchipuram	12. Karur	22. Dindigul
3. Thiruvallur	13. Perambalur	23. Theni
4. Vellore	14. Salem	24. Sivagangai
5. Tiruvannamalai	15. Dharmapuri	25. Virudhunagar
6. Cuddalore	16. Erode	26. Ramanathapuram
7. Villupuram	17. Coimbatore	27. Tirunelveli
8. Thiruvarur	18. Nilgiri	28. Tuticorin
9. Nagapattinam	19. Namakkal	29. Kanyakumari
10. Thanjavur	20. Pudukkottai	

II. PHYSIOGRAPHY

Geomorphologically, three major units are recognised from west to east. The western part comprises the Western Ghats roughly trending N-S and marked by a continuous range of Hills, extending from Nagercoil in the south upto Nilgiri -Bilgirirangan Hills in the north and further northwards through Karnataka. The elevation of these Hills ranges between 1275 m and 2637 m. The prominent Hills are Mahendragiri, Agasthiarmalai, Anaimalai, Palani and Nilgiris. Doddabetta with an elevation of 2637 m is the highest peak in the Nilgiri Hills. The east-west trending Palghat Gap is a prominent physiographic break in the Western Ghats.

The central part of the state is a vast track of dissected pediments and pediplains. Residual Hills in this part viz., Shevaroy, Kalrayan, Chitteri, Kollimalai, Pachchaimalai and Javadi demarcate the extensions of Eastern Ghats, while Karandamalai, Sirumalai and Kodaikanal Hills form another set of residual Hills, further south.

The eastern part of Tamil Nadu and Pondicherry and Karaikkal are marked by a coastal plain with associated landforms like vast tidal flats, continuous beach ridges, estuaries and lagoons and a narrow but fairly continuous beach.

The area is drained by a number of Rivers such as Palar, Cheyyar, Ponnaiyar, Cauvery, Moyar, Bhavani, Amaravathi, Vaigai, Tambraparani etc. flowing ESE from the Western Ghats. Pondicherry and its surrounding lie in the drainage basin of the Gingee River. Karaikkal is located in the fertile Cauvery Delta and is fed by the waters of Arasalar, Nattar, Vanjiyar and Nandalar.

The coastline of Tamil Nadu and Pondicherry comprises a number of cusps, spits and wave cut platforms and several palaeo-shorelines. Some of the palaeo-shorelines extend inland suggesting periods of transgression and regression. The ongoing geodynamic process is generally progradation along the coast, which is modified at several places by erosion and deposition by aeolian and fluvial agents. The eastern areas of the central part of the state are marked by the depositional regime of many Rivers manifested by typical fluvial features like levees, channel bars and palaeochannels, back swamps and vast flood plains.

III. CLIMATE

The climate of the state is tropical monsoon type. In the plains, the temperature during winter seldom goes below 18°C while in peak summer it rises to 43°C. Tamil Nadu and Pondicherry receive rains from both the northeast and southwest monsoons. Maximum rainfall and occasional cyclones occur during the northeast monsoon. The Nilgiris receive the maximum rainfall while Ramanathapuram and Tirunelveli Districts receive low rainfall. The annual rainfall varies between 60 cm and 118 cm.

IV. GEOLOGY AND STRATIGRAPHY

Crystalline rocks of Archaean to late Proterozoic age occupy over 80% of the area of the state, while the rest is covered by Phanerozoic sedimentary rocks mainly along the coastal belt and in a few inland River valleys. The hard rock terrain comprises predominantly of Charnockite and Khondalite groups and their migmatitic derivatives, supracrustal sequences of Sathyamangalam and Kolar groups and Peninsular Gneissic Complex (Bhavani Group), intruded by ultramafic-mafic complexes, basic dykes, granites and syenites. The sedimentary rocks of the coastal belt include fluviatile, fluvio-marine and marine sequences, such as Gondwana Supergroup (Carboniferous to Permian and Upper Jurassic to Lower Cretaceous), marine sediments of Cauvery basin (Lower Cretaceous to Paleogene), Cuddalore / Panambarai Formation (Mio-Pliocene) and sediments of Quaternary and Recent age.

Legend for the Geological Map of Tamil Nadu

The Southern Granulite Terrain (SGT) of India, covering the states of Tamil Nadu and Kerala and the marginal zones of Southern Karnataka, was earlier considered to be the southern extension of the Granite-Greenstone terrain of Dharwar Craton exposed at a deeper tectonic level. This concept was based on the observation that the grade of metamorphism gradually increases from north to south. Geochronological and isotopic studies have brought to light that the southern part of the SGT lying south of Palghat – Cauvery Lineament (PCL) has a geological history distinctly different from the Dharwar Craton. These studies have shown that the terrain lying north of PCL shows crustal growth during the period from 3400 to 2500 Ma. In contrast, crustal growth in the terrain south of PCL is considered to have taken place predominantly during Post-Archaean times, as constrained by Nd model ages (Harris et al., 1994). This terrain might have witnessed several cycles of metamorphism, the most pervasive being the 550Ma Pan-African granulite facies event as constrained by isotopic systematics (Unnikrishnan Warrier et al., 1995b; Jayananda et al., 1995, Bartlett et al., 1995, Ghosh et al., 1998).

In view of the contrasting geological history recorded by the terrains north and south of PCL, the SGT has been divided into the northern Archaean Craton (Dharwar Craton) and the southern Proterozoic (Pandian) Mobile Belt (GSI, 1994) with the PCL marking the boundary between them.

The geological succession of Tamil Nadu and that of the adjoining states of Karnataka and Kerala is more or less common in view of their geographic continuity. The stratigraphy and structure of the Dharwar Craton have been worked out fairly in detail with the back-up of voluminous geochronological data. The geological succession of Tamil Nadu, shown in the published 1:5,00,000 map, was arrived at based on the field data available till 1988. It has thus become necessary to have a relook, on the basis of the recently generated geochronological data and the emerging new concept of Craton-Mobile belt, in view of the important role of South India in the pre-break up configuration of East Gondwana land.

Keeping in view, the points enumerated above, an attempt has been made to prepare a revised

The general geological sequence is given hereunder :-

Era	Period	Age	Group / Supergroup	Formation	Major Rock Type
1	2	3	4	5	6
CAINOZOIC	QUARTER-NARY	Pleistocene to Recent			Fluvial fluvio-marine, aeoline and marine sediments (Q) Laterite/calcareous gritty sandstone and clay (Czl,Czc)
	TERTIARY	Mio-Pliocene		Cuddalore Formation (N_1c) / Panamparai Formation (n_1p)	Sandstone and clay
		Palaeocene		Niniyur Formation (Pg_1n) & Manaveli Formation (Pg_1m)	Limestone with shale / clay / siltstone
MESOZOIC		Cretaceous	Ariyalur Group (Kar) Trichinopaly Group (Kt) Uttatur Group (Ku)		Sandstone with limestone and shale Sandstone with shell limestone, clay and conglomerate Clay with limestone bands, conglomerate
		Lower Cretaceous (GONDWANAS)	Upper Gondwana (JK)	Satyavedu Formation (JKgsv) / Sriperumbudur Formation (JKgsp) / Avadi Formation / Sivaganga Formation (JKgsg)	Shale, sandstone and conglomerate
PALAEOZOIC		Lower Permian (GONDWANAS)	Lower Gondwana (CPgt)	Talchir Formation	Boulder bed, shale and conglomerate
PROTEROZOIC to PALAEOZOIC		390 – 550 Ma	Younger Granite (γPt_3)		Granite

Era	Period	Age	Group	Formation	Major Rock Type
1	2	3	4	5	
		700 Ma	Ultrabasics / basics (Younger) ($\rho\upsilon Pt_3$)	6	Gabbro (υ) Anorthosite (ρ)
NEO PROTEROZOIC		700 - 900 Ma	Alkali Complex (Younger) (ζPt_3)		Carbonatite (ω)ultrabasic complex (σ) Alkaline complex (ζ) Alkaline rocks (ξ) Epidote-hornblende gneiss (Pt_3gn)
MESO PROTEROZOIC		1600 - 2100 Ma	Basic intrusives (βPt_2)		Basic dykes
PALAEO PROTEROZOIC		1900 - 2300 Ma	Alkali Complex (Older) (ζPt_1)		Carbonatite (ω) and alkaline dykes Syenite complex (ζ) Ultrabasic complex (σ)
LATE ARCHAEAN TO PROTEROZOIC		2200 - 2550 Ma	Migmatite Complex ($APt_1m/\gamma APt_1g$) Peninsular Gneissic Complex II		Older grantie / granitoids Pink migmatite Pink augen gneiss Hornblende gneiss Hornblende-biotite gneiss Garnetiferous quartzo-feldspathic gneiss Garnet-biotite gneiss
LATE ARCHAEAN		2600 Ma	Charnockite Group (Ac)		Basic and ultramafic rocks Magnetite quartzite Pyroxene granulite Charnockite

Era	Period	Age	Group	Formation	Major Rock Type
1	2	3	4	5	
ARCHAEAN			Khondalite Group (Ak)	6	Calc granulite Limestone Quartzite Garnet-sillimanite-graphite gneiss
		2900 Ma	Kolar Group (Ako)		Quartzo feldspathic rock Amphibolite Banded ferruginous quartzite
		3000 Ma	(Peninsular Gneissic Complex I) (Bhavani Group) (Ab(p))		Pink migmatite Granitoid gneiss Fissile hornblende gneiss
		3000 3100 Ma	Layered ultra mafic / mafic, ultrabasic complex (σρA)		Ultra mafic / mafic, ultrabasic rocks
		3200 Ma	Sathyamangalam Group (As)		Amphibolite, basic and ultrabasic rocks Sillimanite-kyanite-corundum-mica schist Fuchsite-kyanite ferruginous quartzite

BASE NOT KNOWN

legend for the geological map of Tamil Nadu & Pondicherry. In this exercise, due consideration has been given to the established stratigraphy of the adjoining states while dealing with the group of rocks occurring in geographic continuity. As far as possible all the published data on the geochronology and isotope geology has been taken into account while assigning the new / revised stratigraphic position for some of the rock types / groups in Tamil Nadu.

The crystalline rocks of the state are derived through a complex evolutionary history during Archaean and Proterozoic times with multiple deformations, anatexis, intrusions and polyphase metamorphic events. As a consequence, the areas shown on the map depicting a particular group of granulites/gneisses may include undistinguished portions of similar lithologies of older or younger age. Some linear bands of metasedimentary rocks and basic dykes are exaggerated and shown on the map for better comprehension.

The Cretaceous rocks of Tamil Nadu and Pondicherry are shown in three separate sub-basins, viz., Tiruchirapalli, Vriddhachalam and Pondicherry sub-basins. In each of the sub-basins, the rocks are lithostratigraphically classified into different formations and depicted. However, formations of each sub-basin have not been mutually correlated with similar formations in other sub-basins.

ARCHAEAN AND PROTEROZOIC

Sathyamangalam Group (As)

The vast expanse of granulite – gneiss terrain of central and northwest Tamil Nadu encloses discrete, isolated sequences of high grade schists and basic rocks which occupy a supracrustal status in the lithostratigraphic column. These are referred to as 'Sathyamangalams' in Tamil Nadu. They show geological and geographical continuity with the 'Sargurs' and its equivalents of Karnataka. Their nature of occurrence as rafts and enclaves, association with basic and ultrabasic rocks, structural setting as eroded keels and rootless folds and unique lithology set them apart from other highgrade sequences. The Sathyamangalams are distinguished from Dharwar based on their higher degree of metamorphism and migmatisation.

Sathyamangalam Group (Gopalakrishnan et.al., 1975) consists of Quartzite ± Fuchsite ± Kyanite ± Sillimanite and banded iron stone (Asmf); sillimanite schist ± garnet, kyanite schist, corundam bearing mica schist and talc-tremolite schist (Asmt); calc granulite, crystalline limestone / marble, ortho and para amphibolite (Asma). The fuchsite ± kyanite bearing assemblages are characteristic key markers of the Sathyamangalam Group. The carbonate and ferruginous beds at many places show high proportion of manganese. The rocks of Sathyamangalam Group generally occur as dismembered bands and lenses within the Peninsular Gneissic Complex (Bhavani Group) in an east-west trending linear belt in central Tamil Nadu occupying parts of Coimbatore, Erode, Salem, Namakkal and Tiruchchirapalli Districts. Similar rocks are also known in the northwest in Dharmapuri District which are considered to be the extension of Sakarshanahalli supracrustals (equivalent of Sargurs) of Karnataka.

Although no absolute ages are available for rocks of Sathyamangalam Group, based on close similarities in the litho assemblage, their mode of

occurrence and geographical continuity with the Sargur Group, the Sargur age 3200-3100 Ma (Drury et.al., 1984; Bhaskara Rao et.al., 1996) has been assigned to this group.

Layered Mafic, Ultra Basic Complexes (σρA)

A group of ultrabasic rocks ranging in composition from dunite, peridotite, websterite, garnetiferous gabbro, gabbroic anorthosite and anorthosite occur closely associated with the Sathyamangalam Group in the central belt of Tamil Nadu, around Mettupalayam and other areas. They also occur as enclaves within the Peninsular gneisses as a part of the dismembered sequence. Large volume of garnetiferous gabbro and hornblendic anorthosite with chromitite layers as well as small lenses of eclogitic rocks are the characteristic features of this suite (Gopalakrishnan, 1994b). They are considered to have been emplaced along reactivated lineaments, shear zones, fracture zones or as tectonic slices. The famous Sittampundi Anorthosite (ρA) forms a part of this suite.

The Sittampundi Ultrabasic and Mettupalaiyam Ultramafic complexes have been dated 3000-2900Ma by Sm-Nd systematics (Bhaskara Rao et.al., 1996).

Yet another group of ultramafic and ultrabasic rocks (σA) occur as small bodies, lenses and bands in considerable proportion, in the northeastern sector of Tamil Nadu falling in Cuddalore, Vellore, Tiruvannamalai and Dharmapuri Districts. These bodies include dunite, peridotite, hypersthenite, enstatolite, augitite, hornblendite, websterite, gabbro and anorthosite. These are well exposed around Torappadi, Thenmudianur, Manmalai, Tiruvannamalai and Mamandur. These are considered to be intrusive into precursor rocks of Charnockite Group and later deformed and metamorphosed along with the host rocks under granulite facies conditions (Sugavanam et. al., 1976b, 1978).

Although no absolute ages are available for Torappadi, Manmalai and other complexes, they are grouped along with Sittampundi Complex in view of their broad lithological similarities, layered nature and their occurrence within Late Archaean (2600Ma) granulites.

Peninsular Gneissic Complex I {Ab(p)}

Various types of pink and grey gneisses forming part of the Peninsular Gneissic Complex extend southward from the states of Karnataka and Andhra Pradesh and occur north of Palar River along the northern border of Tamil Nadu. Around Krishnagiri, these gneisses form different textural types of various hues and colours.

In the central part of Tamil Nadu, the gneissic rocks, roughly trending WNW-ESE to E-W to ENE-WSW, extend from the Kerala border in the west through parts of Coimbatore, Erode, Salem, Namakkal, Tiruchchirapalli and Perambalur Districts towards the east coast where they are overlain by Phanerozoic sediments. This gneissic group is named as 'Bhavani' Group after the town of the same name around which typical exposures are seen. Bhavani Group is a mixture of gneisses of different composition and texture such as highly fissile mica gneiss, quartzo-felspathic gneiss, augen gneiss, hornblende gneiss, hornblende-biotite gneiss, biotite gneiss, granitoid gneiss and pink migmatite. Part of these gneisses are considered to be para as well as ortho-gneiss and part their migmatitic equivalents. The gneisses developed in the vicinity

of Moyar and Bhavani shear zones might represent the retrograded parts of charnockite. The Bhavani Gneiss is comparable to the Peninsular Gneiss of Karnataka as geographical / geological continuity exists between them.

Geochronological data are not available for the Bhavani Gneiss. However the basement Peninsular Gneiss occurring to the west of Kolar Schist Belt in Karnataka is dated to be around 3000Ma (Krogstad, et.al., 1988), indicating that this phase of Peninsular Gneiss is of Mid Archaean age. The tonalitic gneiss of Krishnagiri area, however has yielded Rb-Sr (WR) isochron age of 2454 ±164 Ma (NGRI, 1988).

Kolar Group (Ako)

The southern extension of the Kolar Schist Belt of Karnataka and Andhra Pradesh is seen around Veppanapalli, Maharajagadai and Bargur areas of Dharmapuri District. Within Tamil Nadu the schist belt breaks up into three arms and later extends as dismembered lenses and linear patches within the Peninsular Gneiss. The schist belt is made up of assemblages of greenstone rocks designated as Kolar Group comprising biotite, hornblende schists and amphibolites of different types, banded ferruginous quartzite and acid volcanics (Champion Gneiss) represented by quartz - sericite schist and quartzo feldspathic gneiss. Available geochronological data indicate ages ranging from 2700Ma to 2900Ma for the Kolar Group amphibolites and silicic rocks (Bhalla et al, 1978; Hansen et al, 1988).

Khondalite and Charnockite groups

The Khondalite and Charnockite groups and their reworked equivalents occupy large tracts of the state. Although each of the above two groups cover predominantly certain sectors of the state, they are not mutually exclusive, but occur in very close association at many places. Earlier they were collectively classified as equivalents of the "Eastern Ghats Super group" (Narayanaswamy 1971, GSI Subcommittee on Basement rocks, 1975). They occur over long distances and form the Eastern Ghats in neighbouring Andhra Pradesh.

Khondalite Group (Ak)

In Tamil Nadu, Khondalite Group is well developed in the south, i.e., south of Palghat – Cauvery Lineament (PCL) which is considered by some workers as terrane boundary between the Archaean Craton in the north and the Proterozoic Mobile Belt in the south (Harris et.al., 1994, GSI, 1994).

The Khondalite Group essentially consists of rocks of sedimentary parentage such as quartzite and garnet-sillimanite gneiss ± graphite ± cordierite (metapelites). These are interbanded at places with mafic granulite / amphibolite and charnockite. The charnockite interbands rich in diopside are considered to be metamorphosed cafemic sediments, while mafic granulites / amphibolites probably represent mafic volcanics (Gopalakrishnan et.al., 1976).

The metapellites of the Khondalite Group are characterised by Mg-Al silicates such as sapphirine, kornerupine / prismatine and cordierite in Kiranur, Ganguvarpatti, Usilampatti, Rajapalayam, Kambam and other areas (Muthuswami, 1949; Balasubramanyan, 1976; Grew 1982; Subba Rao et.al., 1997; Sriramaguru et.al., 2002). This mineral assemblage is comparable with the pelitic granulites of Eastern Ghats Mobile Belt. The entire lithological

assemblage indicates a distinct continental shelf facies / platformal environment for its formation. The Khondalite Group is intruded by ultrabasics – anorthosite complexes and younger granites.

Rocks similar to Khondalite Group viz., Garnetiferous sillimanite gneiss ± graphite ± cordierite, sillimanite quartzites and calc-granulites are also reported in negligible quantities in the northeastern part of the state occupying the synformal keels within predominantly Charnockite Group. The large volume of quartzite and crystalline limestone in the Khondalitic Group in the southern part are completely lacking in this sector. Recent views (Gopalakrishnan, 1994a) indicate that these meta-sediments have probably formed under different environment in contrast to the platformal conditions of the Khondalite Group of southern part.

Adequate reliable geochronological data are not available for the Khondalite Group in Tamil Nadu. Based on U-Pb Zircon dating, Ghosh et al (1998) opined that the Khondalite Group in Palaiyam area of Southern Tamil Nadu is younger to the Mid-Archaean Sathyamangalam Group. However, the garnet – sillimanite gneiss from adjoining Kerala has given a Rb/Sr whole rock age of 3065 ± 75 Ma (Crawford, 1969). Recent Nd-isotope studies have yielded model Nd ages (TDM) ranging from 2.60 to 1.34 Ga indicating a Palaeoproterozoic age for the Khondalite Group in Kerala (Harris et.al., 1994).

Charnockite Group (Ac)

The Charnockite Group, comprising of charnockite, two-pyroxene granulite, banded quartz-magnetite granulite / banded magnetite quartzite and thin pink quartzo-felspathic granulite are extensively developed in the north-eastern sector of the state and are well exposed in many prominent hill ranges such as Pallavaram – Chengleput, Javadi, Shevaroy, Chitteri, Kalrayan, Kollimalai, Pachchaimalai and Nilgiri. The pyroxne granulite of Charnockite Group are considered to represent mafic volcanics, the banded magnetite quartzite indicates a volcanic exhalative origin, while the pink granulite is interpreted to represent the associated acid volcanics (Gopalakrishnan et.al., 1976, Suganvanam et.al., 1978). In contrast to the essentially sedimentary parentage of the Khondalite Group, the Charnockite Group appears to be of igneous / volcanic parentage derivatives.

Charnockite Group also occurs in the northwest of Dharmapuri and Erode Districts forming the Hills to the west and northwest of Mettur, in the Dimbam-Talawadi and Tattakarai-Tamarakkarai areas. It comprises linear bands and lenses of fuchsite-quartzite, kyanite-sillimanite-garnet schist/ gneiss, magnetite-quartzite and meta-ultramafites. These charnockite is considered to have been derived from the prograde metamorphism of the Peninsular gneiss and the associated Sargur type supracrustal rocks of Dharwar Craton (Srivastava and Kanishkan, 1977).

Charnockite and pyroxene granulite without the associated BMQ and pink granulite occur to a lesser extent in the southern parts of the state, south of Noyil-Cauvery Rivers. They occupy some of the hill ranges such as Kodaikanal, Palani, Sirumalai, Varushanad, Agasthiarmalai and Hills around Nagercoil. Unlike the charnockite of northern Tamil Nadu, the charnockite is associated with higher proportion of meta-sedimentaries such as quartzite, metapellites, calc-silicates/calc-

granulites, which occur as interbands. The metapellites associated with the charnockites are characterised by the presence of cordierite – garnet – spinel – sillimanite – sappharine – orthopyroxenes. The reaction textures observed in these rocks provide valuable information on the P-T conditions of granulite formation and subsequent exhumation. The charnockite is different from those of the northern Tamil Nadu.

Incipient charnockite formation is reported along certain major joint / fracture systems within garnetiferous quartzo-feldspathic granulite near Melur in Madurai District (Ramachandran et.al., 1978), from garnetiferous granulite and gneiss near Papanasam in Tirunelveli District (Whiteman, 1988), from hornblende gneiss and granite near Nartamalai in Pudukottai District (Nathan et.al., 1996), from amphibolite facies gneiss in Andipatti area in Theni District (Sundaravanan et.al., 1999) and in Kadavur area of Karur District (Nathan et.al., 2001). Thus the Charnockite Group shown on the map as a single entity of Archaean age contains in reality, rocks of different ages and origin.

The limited geochrnological data available for charnockites of Tamil Nadu show varying ages ranging from Ca 3000Ma to 550Ma. These data indicate that the charnockites occurring north of Palghat-Cauvery Lineament (PCL) / Noyil-Cauvery Rivers show consistently Late-Archaean ages of 3000-2600Ma, while those occurring south of PCL yield younger ages of 550Ma. The charnockite of type area Pallavaram, Krishnagiri, B.R. Hills and Nilgiri have yielded both whole rock and mineral isochron ages of 2600-2500Ma indicating that the granulite facies metamorphism in northern Tamil Nadu took place during Late-Archaean (Vinogradov et.al. 1964; Crawford 1969; Bernard-Griffiths et.al. 1987; Unni Krishnan Warrier et.al. 1995a; Peucat et.al. 1989; Buhl 1987; Raith et.al. 1996). The time of emplacement of protolith for the Pallavaram, Krishnagiri and Nilgiri charnockites (syn-accretionary granulite) has been constrained to be 2700-2600Ma (Kohler et al, 1996), while the post-accretionary B.R. Hills granulite has given a protolith age of 3400Ma. On the other hand, the charnockites occurring south of PCL in Kodaikanal and Nagercoil massives have given Nd- model ages of 2100-1800Ma and Sm-Nd-Gt-Wr isochron ages of 550Ma indicating that these charnockites represent Palaeoproterozoic protoliths which were metamorphosed during Neoproterozoic times (Jayananda et.al., 1995; Unnikrishnan Warrier et.al. 1995b). As it is difficult to show different types of charnockites separately on the map with the meagre isotopic data available, both these components are shown together for the present.

Migmatite Complex (PGC II) (APt_1m, γAPt_1g)

The granulite terrain of Tamil Nadu has witnessed two major periods of granitic activity – one during Late-Archaean to Early Palaeo-Proterozoic and the other during Neo-Proterozoic times. The granites of older event are restricted to the northern part of Tamil Nadu ie. North of Moyar – Bhavani – Attur Lineament (MBAL), while the younger Pan-African event is widespread in the terrain south of MBAL. The time of emplacement of these granitoids has been well constrained by Rb-Sr isotopic systematics (Nathan et.al. 2001a). Based on these data, the older granitoids are shown as γApt_1, while the younger ones are designated as γPt_3.

Late Archaean-Early Proterozoic periods in Tamil Nadu and Pondicherry are characterised by granulitic facies metamorphism with charnockite formation and concomitant anatexis of earlier rocks. A number of small granite plutons were emplaced as culmination of migmatisation during this period. The Migmatite Complex (APt_1m) shown the map at places includes gneisses and granitoids generated during this period. The Late Archaean granite is developed along the northern periphery of the state (to the north of Palar River) around Tiruttani, Sholingar, Bisanattam, Ebbari and Krishnagiri (Ca 2500 Ma) (Krogstad et.al. 1988; GSI 1991), while early Proterozoic granite is recognised around Gingee, Tiruvannamalai and Tirukovilur (2254Ma; Balasubrahmanyan et.al. 1979).

The rocks of the Khondalite and Charnockite groups have been subjected to regional migmatisation and retrogression with influx of quartzo-feldspathic material resulting in the formation of different types of gneiss such as biotite gneiss, hornblende gneiss, augen gneiss, garnetiferous biotite gneiss, garnetiferous quartzofelspathic gneiss depending upon the parent rock. These rocks are grouped under migmatite complex. The migmatites are generally grey coloured but at many places they are affected by late stage permeation of pink felspar veins caused by potash metasomatism and are converted to pink migmatite (APt_1m).

Bulk of the gneisses in the southern part of Tamil Nadu made up of garnet-biotite gneiss and garnetiferous quartzofeldspathic gneiss represent the migmatised and retrograded equivalents of Charnockite and Khondalite groups (Narayanaswamy and Purnalakshmi, 1967, Narayanaswamy 1971). The complex gneisses made up of hornblende-biotite gneiss, biotite gneiss and granitoid gneiss etc. with remnant patches of Charnockite Group occurring in the Anaimalai Hills and the adjoining areas of Coimbatore and Dindigul Districts are considered as regional migmatites, where different stages of their formation from meta-texites to dia-texites (homophanous pink granite gneiss) could be distinguished (Gopalakrishnan et.al., 1976). Similar migmatite occurring extensively in Vellore, Tiruvannamalai, Villupuram Districts around Tiruvannamalai – Gingee – Tirukkovilur is another example of regional migmatisation of granulite facies of rocks at different stages culminating in homophanous granite (Sugavanam et.al., 1976a, 1978). The different granitoids belonging to the migmatite complex have also been identified (γAPt_1).

Adequate geochronological data are lacking for the Migmatite Complex which are likely to have components of different ages, as the terrain has experienced multiple deformations and polymetamorphism with concomitant anatexis. The Migmatite Complex has been assigned Archaean age. However, it also includes migmatites of younger ages (Early Proterozoic) such as the gneiss east of Coimbatore (2100 Ma, Crawford 1969) and the Gingee Migmatite (2250 Ma, GSI, 1978, Balasubramanyan et.al., 1979).

Alkaline Complexes (Older) (ζPt_1)

In Pikkili and Hogenakkal areas of northwest Tamil Nadu, alkaline magmatism is recorded in the form of several syenite-carbonatite bodies.

The Pikkil Alkaline Complex is represented by nepheline syenite, theralite and camptonite,

which occur as linear concordant bodies and also as ramifying veins within the country rock. The different phases of Pikkili Complex are the earlier melanocratic theralite, essexite, diorite and syenite phase and the later pink alkali syenite – quartz syenite phase.

Pyroxenite, syenite and carbonatite represent the Hogenakkal Alkaline Complex. These are exposed as two NNE-SSW trending parallel bands. Sovite type carbonatite carrying abundant apatite occurs as lenses and veins within pyroxenite and syenite.

The Hogenakkal and Pikkili Syenite complexes have yielded ages of 1994Ma and 2371Ma respectively (Natarajan et al., 1994; NGRI, 1994).

Mafic Dykes (βPt_2)

The northern part of Tamil Nadu, north of Noyil-Cauvery Rivers (north of 11Ύ latitude) is characterised by dyke swarms, in contrast to the areas south of Noyil-Cauvery Rivers where they are absent. In general, the mafic dykes trend WNW-ESE and NNE-SSW and rarely N-S and NNW-SSE. In the central part of Tamil Nadu, ENE-WNW to NE-SW trending mafic dykes (βpt2) are seen transecting the charnockite and migmatites in Nilgiri and Kollimalai Hills.

Although most of these mafic dykes show textural characteristics of dolerite, gabbroic / basaltic variants are not uncommon. The mineral assemblages of these dykes indicate quartz-gabbro / quartz–dolerite composition with minor variations to olivine-gabbro/dolerite. Petrochemical studies indicate that the majority of these dykes are quartz normative tholeiites, while olivine-dolerite dykes show basaltic komatiite chemistry (Krishna Rao and Nathan, 1999). The chemical attributes of these dykes suggest that they were emplaced in a continental tectonic setting. The available K-Ar ages for the mafic dykes of Tamil Nadu are clustering around 1700Ma (Radhakrishna and Mathew Joseph, 1993; Sarkar and Mallick, 1995) indicating that they were emplaced during a major extensional tectonic regime in the Southern Peninsular Shield.

Alkali-Syenite-Carbonatite Complexes (Younger) (ζPt_3) (ξPt_3, σPt_3, ωPt_3)

The Late Proterozoic period in Tamil Nadu witnessed large-scale extensional tectonism with the formation of deep crustal fractures with intrusion of alkaline related plutons and granites. The alkaline related plutonism was widespread in the north in parts of Vellore, Dharmapuri and Salem Districts, where a number of ultramafic-syenite-carbonatite bodies of Elagiri, Koratti, Samalpatti and Pakkanadu occur in a NNE-SSW trending zone extending from Gudiyattam in the north to Bhavani in the south over about 200km. A number of smaller ultramafic-syenite-carbonatite bodies also occur along sub-parallel NNE-SSW trending fault/ shear zones on both sides of the main zone of alkaline activity. Recent studies indicate that the alkaline plutonic activity extends further NNE, beyond River Palar.

The Gudiyattam-Bhavani zone of alkaline activity is also characterised by the occurrence of very coarse granular epidote-hornblende gneiss (Pt_3gn), which is not seen in other parts of Tamil Nadu on such a large scale. This gneiss is leucocratic to mesocratic with varying proportion of coarse hornblende, feldspar, streaky quartz and granular epidote have the composition varying

from granodiorite to quartz-diorite. These are considered to have formed due to epidote-amphibolite facies retrograde metamorphism of the pre-existing rocks of Charnockite Group. This restricted development of epidote-hornblende gneiss in the zone of alkaline activity implies possible hydrothermal activity generated during the extensional tectonics at the early stage of alkaline plutonism (Gopalakrishnan, 1994a). The epidote-hornblende gneiss zone also includes areas where large-scale carbonatisation, marked by siderite-ankerite permeation into the older rocks has taken place during the alkaline activity (Gopalakrishnan and Subramanian, 1990; Gopalakrishnan, 1994a).

The alkaline plutons within the Gudiyattam-Bhavani zone form large sub-oval ring complexes of phacolithic emplacements in which the ultramafic components (σPt_3) consisting of the early differentiates of dunite and pyroxenite occupy the outer periphery of the pluton with successive differentiates of different types of syenite (ξPt_3c) and rare carbonatites (ωPt_3). The ultramafics occur in large proportion in the Samalpatti pluton and they carry large chunks of ilmeno-rutile, at places. Magnesite is also noticed within this body, to a limited extent. The pyroxenite occurring in the northern margin of Koratti pluton has converted to vermiculite due to intrusion of carbonatite. The ultramafic body in the Pakkanadu pluton occupies the core in contrast to other plutons.

Carbonatite is rare in the Elagiri pluton, but is well developed along the northwestern fringes of Koratti pluton generally of sovite composition. Small carbonatite bodies, of both sovite and beforsite composition occur within the Samalpatti pluton. Benstonite (barium bearing carbonatite) is reported from Jogipatti within the Samalpatti Complex. The Pakkanadu carbonatite carries large crystals of monazite and allanite.

The syenites of these ring complexes show variation in colour, composition and textures. They are all saturated to over saturated in silica. The colour varies from various shades of pink, grey and white. They include fine, medium and coarse to very coarse-grained types and occasionally pegmatoidal. They are undeformed and preserve igneous cumulus texture as well as primary flow texture, particularly in the porphyritic types.

Besides these silica saturated alkali plutons, there are two bodies of silica undersaturated syenite complexes, namely the Pikkili and the Sivamalai syenites. In contrast to the saturated syenites these bodies are devoid of carbonatite association and are characterised by pyroxene syenite, ijolite, nepheline syenite and corundum syenite. Again in contrast to the oval shape of the alkaline carbonatite plutons, these foidal syenite bodies are linear in shape.

Minor carbonatites with magnetite have been recorded along the slopes of the Western Ghats near the Kerala border around Kambamettu and Kothagudi in Theni District. Minor veins of siderite-ankerite bearing carbonatite with rare sovite types are recorded in the carbonated zone in Attur valley in Salem District. The Salem ultramafic body, famous for its magnesite deposit is considered to be related to this syenite-carbonatite activity.

The late phase of syenite-carbonatite plutonism witnessed emplacement of a number of thin basic/ alkaline dykes, felsite, syenite pegmatite and quartz-baryte veins. Many of them are unmappable and cannot be shown on the 1:2 million scale map.

The time of emplacement of these alkaline plutons has been well constrained by different isotopic systematics. The available ages for the Elagiri, Koratti, Samalpatti and Pakkanadu complexes occurring within the main Dharmapuri Alkaline Province range between 700 and 900Ma (Deans and Powell, 1968; Morolov et.al., 1975; Krishna Rao and Nathan 1991; Anil Kumar and Gopalan 1991; Miyazaki et.al., 2000). The Salem Ultramafic Complex has also yielded an isochron age of 808 ± 18Ma (Reddy et.al., 1995). Although the Sivamalai silica undersaturated syenite-carbonatite complex was earlier dated 1020 ± 670Ma (Crawford, 1969) recent studies have shown that it was also emplaced contemporaneously (623 ± 21 Ma) with the plutons mentioned above (Subba Rao et al., 1994).

Ultrabasics / Basics (Younger) ($\rho\upsilon Pt_3$)

The anorthosite and ultramafic rocks of Oddanchatram, Kadavur and Tirunelveli of Southern Tamil Nadu occur in a different tectonic domain indicating that they were possibly emplaced within a Palaeoproterozoic crust which has undergone granulite facies metamorphism during Pan-African (550Ma) times.

The host granulite (Kodaikanal charnockite) for the Oddanchatram Anorthosite has been dated 550Ma by Pb-Pb and Sm-Nd systematics (Bartlett et.al., 1995; Jayananda et.al., 1995). The zircons separated from the Oddanchatram Anorthosite have also yielded U-Pb ages of Ca 600Ma (Ghosh et.al., 1998).

The Kadavur Anorthosite is distinctly post-tectonic and it does not show the imprint of granulite facies metamorphism. A sample of hornblende gabbro from this body has yielded K-Ar mineral age of around 600Ma (Balasubramanyan and Sarkar, 1981).

The mineralogical attributes (An-content of plagioclase) of the Kadavur and Oddanchatram anorthosites also indicate that they represent the Proterozoic massive type anorthosite. Hence, these two bodies are dealt under younger ultrabasics / ultramafics.

Granite (Younger) (γPt_3)

Central and south of Tamil Nadu were affected by a major tectonothermal event during Late-Proterozoic to Early-Palaeozoic resulting in the emplacement of several granite plutons. In central Tamil Nadu, four major granite plutons viz., Sankari – Tiruchengode, Punjai Puliyampatti, Karamadai and Marudamalai granites occur in a ENE-WSW trending linear array within a lithotectonic zone which is bounded by two major lineaments. These late-to post-tectonic granties are emplaced within the amphibolite facies gneiss and associated pelite-carbonate sequence of Sathyamangalam supracrustals and the layered ultramafic-mafic-anorthosite complexes of Archaean age.

These granites show two distinct phases, viz. a leucocratic, medium grained to pegmatoidal granite and a pink coarse to pegmatoidal granite. While the leucocratic varieties are well developed in the eastern plutons, viz. Sankari-Tiruchengode and Punjai puliyampatti, the pink granite is dominant in the Karamadai and Marudamalai bodies. The leucocratic pegmatoidal granite shows mineralogical and chemical composition of Trondhjemite, while the composition of the pink granite is in the range of alkali granite – quartz monzonite (Nathan et. al., 1994). They also show contrasting REE distribution pattern, as the former is enriched in

HREE while the latter shows anomalous concentration of LREE due to allanite mineralisation (Nathan and Kanishkan, 1996). The geochemical signatures of these granites broadly characterise them as A-type granites emplaced in a "Within Plate" tectonic setting (Nathan et.al., 2001a).

In south Tamil Nadu, major granite bodies are found around Pudukkottai, Vanjinagaram, Pulangkurichi and Nagamalai - Minakshipuram. Besides these, minor bodies of granites occur in Tiruchirappalli and Kambam. These granites are mostly pink potash feldspar rich varieties and they occur within charnockite and the associated quartzite-pelite-carbonate sequence of Khondalite supracrustals and their retrograded equivalents.

Geochronological and isotope studies of these granites indicate that they were emplaced during Late-Proterozoic/Early-Palaeozoic times. Rb-Sr dating of the leucogranite (trondhjemites) of the Sankari-Tiruchengode pluton has yielded whole-rock isochron ages of 534±15 Ma (Pandey et al., 1993) and 479 ± 12Ma (Ghosh et al., 1996). The pink pegmatoidal granite of the same pluton, however, has yielded an younger age of 390±40Ma (Nathan et al., 1994). The Maruda Malai, Vanji Nagaram and Pudukkottai granites have yielded Rb-Sr isochron ages of 619 Ma, 620Ma and 531Ma respectively (Nathan et al., 2001a). The uniformly higher initial Sr-isotope ratios shown by these granites suggest that they were mainly formed by crustal anatexis.

PALAEOZOIC SEDIMENTS (CPgt)

Along the coast, the crystalline rocks of Tamil Nadu and Pondicherry are overlain by Phanerozoic sediments. The Talchir Formation (CP) comprising boulder bed, conglomerates, olive green to khaki coloured splintery shale with minor pink sandstone of Lower Gondwana age (Carboniferous to Permian) (Ahmed, 1966; Murthy and Ahmed, 1977) is well developed in the Palar basin in the northeast. Talchir rocks occur in two N-S trending linear belts in the southern part of the basin. The maximum thickness of Talchir sediments as intersected in the stratigraphic borehole is + 345 m, which underlies 200 m thick fluvatile sediments of Sriperumpudur Formation. The palyno-fossil assemblage consists of *Virkki pollenites, Plicati pollenites, Potoniei sporites, Lumati sporities,* which are indicative of early Permian Age. The shale from Guduvancheri, Karsangal and Nattam has yielded microfloral assemblages with some acritarh, which suggests marine influence (Murthy and Ahmad, 1971).

MESOZOIC SEDIMENTS (JK)

Mesozoic rocks are exposed in five sub-basins along the Tamil Nadu and Pondicherry coast, namely 'Palar', 'Pondicherry', 'Vriddhachalam', 'Tiruchirapalli' and 'Sivaganga' sub-basins. The Mesozoic rocks are represented by Upper Gondwana formations (Late Jurassic-Early Cretaceous) and marine Cretaceous rocks.

Upper Gondwana rocks occur in three sub basins - 1) near Sivaganga in Sivaganga District, 2) near Terani and Uttattur in Perambalur District (along the contact zone of crystallines with marine Cretaceous sediments) and 3) near Sriperumbudur and Satyavedu in Tiruvallur District.

The Sivaganga Formation is comprised of basal boulder bed, conglomerate, micaceous sandstone and shale, exposed around Sivaganga. The shale bears a lot of plant fossil impressions. Phytoplanktons and well-preserved fruits belonging to microthyriaceas are also recorded. These forms indicate Lower Cretaceous and marine influence at the time of deposition.

The Terani occurrence is made up of white and variegated clays and sandstone rich in plant fossils. The Terani sediments are faulted against the basement. However, basal non conformity is also observed. The upper contact is gradational into marine strata of Maruvattur Formation of Uttattur Group. The leaf impressions of *Ptillophyllum cutchense* and presence of ammonite indicate Burremian age. However, intertonguing with the overlying Uttattur Group suggests Burremian to Lower Albian age.

Sriperumbudur Formation and Satyavedu Formation are also made up of basal conglomerate, sandstone and shale with minor limestone. Similar flora is recorded from these three formations and is given below.

1.Plant fossils : *Ptilophyllum actutifolium, P.cutchense, Taeniopteris spatulata, Cladophlebis sp.*

2.Palynofossils : *Callialasporities sp., Alisporites sp., Araucarites sp., Cyathidites sp.*

In Palar basin, Lower Cretaceous marine sediments are termed as Avadi Formation. Inter tonguing facies relationship amongst the three Cretaceous formations viz., Sriperumbudur, Satyavedu and Avadi is inferred from field and borehole data. In Sivaganga, Tiruchirapalli and Palar sub-basins fossil evidences indicate marine intercalations. Overall the Lower and Upper Gondwana formations cover 4200 sq km area.

MARINE CRETACEOUS SEDIMENTS (K)

Marine Cretaceous rocks distributed in 1) Tiruchirapalli, 2) Vriddhachalam and 3) Pondicherry sub basins have been lithostratigraphically divided into different groups. In Tiruchirappalli sub basin these are divided into three groups viz. 1) Uttattur (Kpa), 2) Trichinopoly (Kt) and 3) Ariyalur (Ka). In the three sub-basins, these groups are variously classified into different formations lithostratigraphically and are shown separately in the legend. The different formations in the three sub-basins are not mutually correlated.

In the Tiruchirapalli sub-basin, the Uttattur Group (Kpa) is divisible into Lower Maruvattur Formation made up of limestone, mud and clay and Upper Karai Formation* consisting of gypseous clay and sandstone with lenses of limestone. The limestone is fossiliferous with abundant lamellibranchs, gastropods and lesser association of corals. Sastry et al (1968) delineated the Uttatur Group into three zones viz., *Scholenbachia inflate* zone, *Calycoceras newboldi* zone and *Mammites conciliatum* zone based on the study of ammonites and suggested an age range from Albian to Lower Turonian. Lower and middle parts of Karai Formation contain rich Late Albian and Cenomanian fossils respectively (Sastry et al., 1968, Ayyasami 1990). Its upper beds contain ammonites of Early Turonian age. Venkatachalapathy and Ragothaman (1995) suggested Late Aptian or Early Albian to Late Turonian.

Trichinopoly Group is divided into Kulakkalnattam Formation* made up of sandstone and clay with shell limestone and calcareous limestone, overlain by Anaipadi Formation comprising shale, silt, limestone and sandstone with bands of calcareous grit. The famous 26m long fossil tree in Sattanur village discovered by Dr. M.S.Krishnan in 1940 preserved in the lower beds of Kulakkkalnattam Formation and the giant ammonites preserved in Anaipadi Formation are characteristic features of this group. The coquinite which is popularly known as *Trichinopoly marble* is light to dark grey and carries *lamellibraches* and *gasteropods* of varied sizes in abundance; occasional ammonites are also found. Anaipadi Formation is richly fossiliferous with plenty of molluscan fauna and ammonites, particularly *Lewiceras* and *Eutrephoceras*. One of the best fossil localities is the nala section east of Anaipadi village. The lower member of the Anaipadi Formation more or less corresponds with *Lewessiceras vaju* zone and *Kossmaticeras theobaldianum* zone {dated upper Turonian and Conacian by Sastry et al (1968)}. The upper member contains a less diverse ammonite fauna, assigned to the *Palacenticeras tamulicum* zone and placed at Santonian.

The Ariyalur Group (Ka) rests over the Trichinopoly Group with an unconformity and is essentially made up of sandstone, limestone and shale. This group is divided into Sillakkudi*, Kallanakurichchi* and Kallamedu formations* in the ascending order (Sundaram, 1976, 1977 and Sundaram and Rao, 1981). The Sillakudi Sandstone is fossiliferous; giant size of *Inoceramus* fossils are preserved besides ammonites like *Hauericeras*. Biostratigraphically the Sillakudi Formation is recognised as *Karapadites Karapadense* Zone by Sastry et al (1972) and assigned Campanian age. Fossils commonly noticed in Kallankurichi Formation are *gryphea, inoceramus, pycnodonte* and *bryozoans*. Ammonites (Hauericeras rembda) indicate a Maestrichtian age (Ayyasami 1990, Sastry et al 1968). In Kallamedu Formation, fossils (*lamellibranches, rudistids, echinoids and bryozoans*) are commonly found around Ootakkovil village. In the higher horizons fossils are very rare. Dinosaurian remains are reported from the sandstone beds in the vicinity of Kallamedu village. Fossils ammonites and rudistids indicate Maestrichtian age (Ayyasami 1990). Planktic foraminifera indicate a late Maestrichtian age.

In the Vriddhachalam sub-basin, the Upper Cretaceous rocks rest on charnockite and are represented by the Ariyalur Group (Kar) with the absence of basal Uttattur and Trichinopoly groups. Cretaceous sediments consist of pebbly and cobbly sandstone with shale interbeds, clay with limestone bands and calcareous sandstone with soft argillaceous sandstone. These have been divided into Parur (*), Patti (*), Mattur (*) and Aladi (*) formations in ascending order (Sundaram, 1978, 1979). In Mattur Formation, ill preserved lamellibranches and gastropods are often found in the calcareous sandstone. South of Erumanur lot of *Ostrea sp. Exogyra sp. and stygmatopygus sp.* were collected. The formation may be of a Campanian – Maestrichitan age. The rocks closely resemble Kallankurichi Formation of Ariyalur Group. It is surmised that the rocks in the uppermost horizon may be of Paleocene age.

In the Pondicherry sub-basin, the Mesozoic rocks representing the Ariyalur Group (Kar) are made

up of argillaceous and micaceous sandstone with bands and lenses of limestone, clay sandy clay and siltstone with fine grained argillaceous sandstone. These are divided into a lower Vanur Formation (*) and an upper Nesal Formation (*) (Sundaram, 1980). Vanur Sandstone is fossiliferous; fragments of lamellibranches are invariably seen. In the upper levels the hard calcareous sandstone carries fossils. Lot of pelecepods, lamellibranches, gasteropods and ammonites are reported, indicating Maestrichtian age. Occurrence of *Golbotruncana calcarata* confirms Maestrichtian age.

(In the map only three major groups are shown. Individual formation cannot be shown on this scale).*

TERTIARY SEDIMENTS (Pg_1)

Ariyalur Group of Upper Cretaceous is overlain conformably by a sequence of limestone, calcareous shale/mud, clay and sandstone of Paleocene age. This sequence is named as Niniyur Formation (Pg_1nt) in the Tiruchirapalli sub-basin, and its equivalent in Pondicherry sub-basin as Karasur Formation (Pg_1np). Manaveli Formation (Pg_1mkp) which succeeds Karasur Formation is also of Paleocene age. However, the upper beds are suspected to be Eocene in age.

Rocks of Mio-Pliocene age (early Neogene) termed as Cuddalore Formation (N_1c) occupy a large area along the coast overlapping on to the Mesozoic sediments and at places over the crystalline basement. Cuddalore Formation consists of mottled, fine to coarse grained yellowish to brownish ferruginous sandstone, pebbly and cobbly sandstone, hard compact claystone and light greenish grey clay with rare bands of limestone. The claystone is of reddish, pinkish and whitish colour, compact in nature and kaolinitic composition. Cuddalore Formation contains large quantities of fossil wood around Tiruvakkarai in Villupuram District which have been declared and maintained as a National Fossil Wood Park by GSI. Thick lignite beds at Neyveli in Cuddalore District was originally thought to belong to Cuddalore Formation. Recent palynological studies by GSI and ONGC indicate that the lignite beds around Neyveli are of Eocene age and not a part of the Cuddalore Formation. The emerging lithological and palaeontological data on regional basis favours the inclusion of the lignite and associated sediments under a separate formation viz., Neyveli Formation (Kumaraguru, 1983, Kumaraguru et al, 2002, Siddhantha, 1986). Although Cuddalore Formation is essentially made up of continental deposits, some of the recently bore holes drilled around Neyveli have indicated marine intercalations pointing to marine transgression during Mio-Pliocene times.

In the coastal tract of Tuticorin and Tirunelveli Districts, a group of fine grained limestone and gritty sandstone intercalated with pebble beds are found to overlie the Archaean unconformably and below the recent formations. These are referred to as Panamparai Sandstone and their fossil assemblage indicates Mio-Pliocene age. The entire assemblage of Panamparai points to a mixture of continental and marine derivation (Narayanaswamy, 1947).

Along the west coast of Kanyakumari District, a sequence of sandstone and clay with thin lignite seams is recorded. These are correlated to Warkhali beds of Mio-Pliocene age of south Kerala and are similar to Cuddalore Formation.

QUATERNARY SEDIMENTS (Cz)

Post Pliocene rocks are represented by calcareous mud, clay, calcareous sandy clay and gritty sandstone (Czc) in the Kambam valley in the western parts of Theni and Madurai Districts. These fresh water sediments occupy elongate NNE-SSW trending structurally controlled basins (Murthy, 1969). Rare vertebrate fossils of Tertiary age are recorded in them (Muralidharan and Rajaram, 1995).

Around Kanchipuram, close to the Upper Gondwana rocks, an arenaceous formation consisting of pebbles and shingles of quartzite and vein quartz referred to as Conjeevaram gravels (not shown on the map) (Murthy, 1953) of probable Pliocene to Lower Pleistocene age is exposed. Kankar and tuffaceous limestone occur in the southern part of Tuticorin District and southeastern part of Coimbatore District. Kankar occurs as conspicuous high grounds along the margin of black cotton soil.

Beds of open textured loosely indurated, coarse calcareous gritty sandstone and shell limestone are found in the coastal tracts of Tuticorin District (Narayanaswamy 1947, Narasimhan 1961, Venkatesan 1967, Sankaran 1972). These are mostly covered by red "Teri" sands. Similar calcareous gritty sandstone (Czc) is recorded near Soyamali in Tirunelveli District beneath the kankar. It carries vertebrate fossils of probable Pleistocene age (Narayanaswamy 1945).

Laterite (Czl) associated with reddish brown ferruginous clayey soil caps the crystalline rocks at high altitudes in Nilgiri, Shevaroy, Palani, Kodaikanal, Anaimalai and Kollimalai Hills as well as over the coastal sedimentaries at low levels mainly in Pudukkottai, Perambalur, Ramanathapuram and Cuddalore Districts and at places in Tiruvallur District. While the high level laterites carrying pockets of bauxite are probably of Eocene age, the low level coastal laterites are considered to be of Post Mio-Pliocene (post-Cuddalore Formation) age. The high level laterite has not been demarcated separately on the map.

LATE PLEISTOCENE TO RECENT SEDIMENTS (Q)

The Quaternary formations occupy a total area of about 22,750 sq. km. mainly along the east coast and along some of the major River valleys. They include fluvial deposits (Qf) along the River valleys and deltas with gypsum rich black soil in some interior basins, the marine deposits (Qm) along the coast and aeolian (Qa) deposits of 'teri' and other types of sand near the coast. The above Quaternary formations are however not grouped lithostratigraphically / lithologically but only genetically into fluvial, fluviomarine, aeolian and marine deposits. All the Quaternary sediments are shown under one symbol (Q) in the map.

The red sand or 'teri' as known locally occupies a great part of the coastal districts of Ramanathapuram, Tuticorin and Tirunelveli. The 'teri' lies some distance away from the shore and forms large barren wasteland of high mounds and ridges composed of piles of red dunes with intervening depressions. The formation is made up

mainly of red stained quartz with an admixture of fine red clayey dust and fine grains of iron ore. The thickness of teri sand increases from the coast the interior from about 1.5m to maximum 7.0 m. Aeolian sand dunes of smaller dimensions amidst the crystalline rocks and at places over the Cainozoic calcareous sediments are reported in the Kambam valley of Theni District about 140 km away from the coast. The sands are composed of quartz, fragments of felspar, magnetite and rare garnet.

The alluvial soils vary in colour and texture from light brown to dirty white and are composed of sand grains, clay and silt. They are more sandy along River and stream courses but silty and clayey in the flood plains.

Wide patches of black soil with nodules of gypsum are recorded in parts of Coimbatore, Virudhunagar, Ramanathapuram and Tuticorin Districts. Black soil generally overlies calcrete/ kankar. These are considered to be deposited in some inland marshy basins developed during the Quaternary (Gopalakrishnan, 1975). The black soil areas are not shown on the map.

Along the northern coast of Chennai and Thiruvallur districts, an arenaceous formation called Coromandal Formation (Badrinarayanan, 1978) of probable Holocene age has been recorded below the beach sand. This formation is essentially a quartz arenite which at places grades in depth to clayey sand and sandy clay.

The Quaternary coastal deposits are large linear tracts of beach sand mixed with shell fragments seen along the raised beach terraces forming the present and palaeo shorelines as well as the soft black clay carrying marine shells occurring in a number of backswamps, tidal flats, lagoons and estuaries. Beach sands in the raised dunes are often underlain by a bed of pure white sand of glass and foundry grade, which is considered to be the reworked Coromandal Sandstone (which is not exposed and therefore not shown separately on the map or in the legend). These are seen at places between north of Chennai and south of Vedaranniyam along the east coast.

V. GROUND WATER SURVEYS

Between 1954 and 1957, detailed hydrogeological studies conducted in Neyveli lignite field established the feasibility of controlling the artesian aquifer for safe and economic mining of lignite. During 1956-57, investigation of Minjor-Ponneri area and in 1962 Arakkonam to Madras areas was carried out to assess the potential of Cooum, Kortalayar and Arani Ar basins. The Cooum basin was found to be unfit for large scale exploitation; the Kortalayar Basin was found to have the potential of 5-10M gal/day and Araniyar 10M gal/day.

During 1957-58, thirty-five boreholes were drilled in Cuddalore, Tiruchirapalli, Thanjavur and Ramanathapuram Districts and a subartesian aquifer was identified between Avudayarkoil and Tiruvadanai. During 1962-64, the potential of Palar basin was studied. During 1969-71, systematic geohydrological studies were taken up in all Districts and a permanent network of observation wells was installed for collection of data on seasonal water level fluctuations. During the drought of 1974-75 in Chennai city the ground water potential of Tiruvanmiyur-Kovalong coastal tract was discovered and estimated as 2Mgal/day and is being currently exploited. After the formation of Central Ground Water Board in 1971, the geohydrological work was taken up by them.

VI. STRUCTURE AND TECTONICS

In Tamil Nadu - Pondicherry terrain crystalline rocks cover about 85% of the total area with the Phanerozoic sediments occupying the rest. The Phanerozoic sediments show well preserved bedding planes where the dips vary from horizontal to 10Υ. The crystalline rocks on the other hand, had undergone polyphase deformation and metamorphism. In certain less deformed areas, the quartzite of Khondallite Group shows well-preserved ripple marks as seen in the Alagarmalai Hills in Madurai District (Venkatesh, 1979). Similarly, the intrusive igneous rocks show primary layering/ flow banding and cumulus textures as in the case of alkali plutons, which are undeformed. Even in some of the deformed ultramafic - anorthosite complexes such as the Sittampundi Complex of Archaean age, primary layering and cumulus texture are recorded in less deformed zones (Ramadurai, et al, 1975 and Windley and Selvan, 1975)

The multiple deformations undergone by the crystalline rocks have induced well-developed foliation (S_1), which follows the litho contacts at many places. Subsequent deformations have induced local development of new S fabrics. However, these are not indicated on the map.

FOLDS AND FAULTS

The multiple deformations experienced by the Archaean - Proterozoic rocks have affected them differently in different sectors. A close scrutiny of the folding history of these rocks generally indicates three recognisable phases. The earliest one is often folding of isoclinal to reclined type (F_1) which has been refolded in to open upright folds (F_2). In certain sectors, the second deformation is co-axial with the earliest one. The third deformation is often in the form of warps or open upright round hinged folds oblique to the first phase of folds, producing dome and basin structures.

In the northeast, the regional structural trend is NNE-SSW. This sector is characterised by long linear canoe-shaped folds as a result of F_2 deformation. The northwest is characterised by nearly N-S regional structural trend. Although polyphase folding has been recognised in this terrain, no distinct regional structures have been interpreted. In the central part, the regional structural trend is E-W often swerving to ENE-WSW and WNW-ESE. The southernmost sector, to the south of Tambraparani River shows a distinct NW-SE structural grain.

The Pre-Cambrian terrain of Tamil Nadu is extensively fractured and deeply faulted particularly in the northern and central parts. Not all the faults, shear zones and fracture zones have been depicted on the map. The details about the major faults, shear zones and dislocation zones have been brought out by Vemban et.al. (1972). Several workers (Drury et al, 1982; Gopalakrishnan, 1996) have produced fault/ lineament map of Tamil Nadu from satellite imagery and aerial photo studies. The major fault and fracture systems of Tamil Nadu are oriented in the following directions:-

1) Nearly E-W to WNW-ESE.
2) NNE-SSW to NE-SW.
3) ENE-WSW
4) N-S
5) NW-SE

In southcentral Tamil Nadu, covering parts of Theni, Madurai and Dindigul districts, three distinct zones of diverse structural trends, viz., NE-SW, NW-SE and N-S are noticed. These three zones are named respectively as Suruli Ar Lineament Zone (SALZ), Vaigai Lineament Zone (VLZ) and Vattlagundu – Idaiyakkottai Lineament Zone (VILZ). Based on their mutual relationship, the NE-SW structural element which is prominent in the west as seen in the Kambam – Periyakulam area (SALZ) is the earliest and are being cut by the NW-SE structural trend (VLZ) which is prominent in the Vattlagundu area and further southeast. The N-S shear / fault is prominent in the Dindigul area, and it transects both NE-SW (SALZ) and NW-SE (VLZ) structural trends and hence the youngest in the area. The earlier compressional tectonic regime, manifested by recumbent folding and thrusting, followed by tensional regime in the Kambam valley resulted in the development of a series of NNE-SSW trending horsts and grabens with the latter occupied by Quaternary sediments. Emplacement of alkali granites and carbonatites marks the extensional tectonic regime in this domain.

SHEAR ZONES

Considerable work has been carried out in the following shear zones, in recent decades.

Moyar Shear Zone

The Moyar shear zone defines the northern limits of the Nilgiri Hills. The length of this WNW-ESE shear zone is about 200 km and its width is nearly 20 km. Srikantappa (1993) considered this shear zone as a suture zone. However, according to Naha and Srinivasan (1996), the Moyar Shear Zone is neither extensive nor its effect as pervasive as formerly believed. The most intense shearing is restricted to a maximum width of two kilometres on either side of Moyar River. The slip directions show a range in pitch from 60 to 90ϒ on the shear planes, a large number of them being down dip. They further opined that any suggestion of change in trend due to movement along the Moyar shear is untenable.

Bhavani Shear Zone

The Bhavani Shear Zone passes through the southern margin of the Nilgiri Hills. Towards ENE this tends to merge with Moyar Shear Zone and towards WSW it extends upto silent valley through Attapady. Retrograde biotite within the gneiss in the shear zone yield Rb – Sr ages of 521 to 472 Ma and some of the coronitic garnet in a meta-dolerite yield an age of 552 Ma indicating Pan African tectonothermal events in the Moyar – Bhavani Shear Zones (Srikantappa, 2001). Occurrence of pseudotachylite along the shear zone indicates frictional heating. The Bhavani Shear Zone, according to Naha and Srinivasan (op.cit.) is upto 2 km wide south of Mettupalaiyam.

Salem – Attur Shear Zone

The Salem – Attur Shear Zone is about 100 km long and 2 to 5 km wide and passes through a valley extending from Salem to Attur. The average trend of the shear zone is EW. Mylonitisation is well at places and this zone is characterised by 1 to 1.5 km wide zone of phyllonite. Evidence of dextral (Chetty, 1996, Bhadra, 2000) and sinistral movements have been recorded along this shear zone. Intense hydrothermal alteration along this shear zone is manifested by siderite – ankerite veins within the retrograded gneiss (Khan and Janardhan, 1989).

Cauvery Shear Zone

The average strike of this shear zone is EW. Gopalakrishnan (1994a) has advocated a 400 km long 60 km wide EW trending Cauvery Suture Zone bounded by Moyar – Bhavani Attur Lineament in the north and Palaghat – Cauvery Lineament in the south. Several workers have interpreted this as a dextral shear zone, which has dragged the Dharwar trend. However, the observations of Mukhopadhyaya et al (2001) do not support this. According to them, dextral shear would have caused layer elongation and not folding of a pre-existing northeasterly gneissosity. The fold pattern, as recorded by them (op.cit) is suggestive of shortening across the zone rather than simple transcurrent motion. Small scale layer parallel shearing, which is ubiquitous in the area, is related to the late folds. They have further opined that the regional retrogression of granulite is unrelated to shearing.

Dharmapuri Shear Zone

This 200 km long 50 km wide zone extends from Bhavani in SSW to Gudiyattam in the NNE. The bounding lineament of this zone are Mettur – Palakkadu lineament in the west and Javadi Hills West lineament in the east. Neoproterozoic alkali magmatism and significant molybdenite mineralisation are reported in this zone. A number of diatreme breccia plugs are intermittently exposed along the eastern boundary of this zone near Singarapettai and Alangayam.

Gangavalli Shear Zone

This 100 km long shear zone trends NNE-SSW and separates Kollimalai and Pachaimalai massifs (Palanisamy et al, 1990). The shear zone rocks have been mylonitised to varying degrees producing mylonite and, at places pseudotachylite. Brecciation and retrograde metamorphism have taken place along the shear zone.

Achankovil Tectonic Zone

The Achankovil Tectonic zone passes through the southern tip of the granulite terrain. It trends NW-SE and is about 150 km long with an average width of 8 km. A dominant strike slip movement has been suggested along the shear zone (Harris et al 1982).

Specialised thematic mapping in the recent years has brought out evidence for tectonic movement in the form of thrusting and tectonic slicing near Toppur between Salem and Dharmapuri (Baskaran et al, 1997), in Cumbum (Sundaravanan et al, 1997) and Ganguvarpatti (Sundaravanan et al, 1999).

The coastal zone of Tamil Nadu and Pondicherry had experienced block faulting with the formation of pericratonic basins where the Phanerozoic sediments were deposited. The basin architecture is horst-graben type which include several depressions separated by sub-surface basement ridges (Sastri et. al., 1981; ONGC, 1993).

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VII. MINERALS IN TAMIL NADU AND PONDICHERRY

Tamil Nadu and Pondicherry are endowed with several minerals of which a few are exploited economically. The important minerals include fossil fuel lignite, metalliferous minerals such as base metals, bauxite, chromite, gold, magnetite iron ore, molybdenum and non-metallic and industrial minerals such as apatite, rock phosphate, asbestos, barytes, clay, corundum, construction material (dimension stones), feldspars, gemstones, graphite, gypsum, heavy mineral sand, limestone, magnesite, mica, ochre, moulding and glass sand, quartz, sillimanite, steatite and vermiculite. Besides these, minor occurrences of minerals such as beryl, celestite, columbite-tantalite, garnet, ilmenite, kankar, nickel ore, pyrite, allanite and salt are also recorded. These have been indicated on the map by standard symbols. Some of the important mineral deposits/ prospects are described below.

FOSSIL FUELS

Lignite

The lignite in the Cauvery Basin of Tamil Nadu was a chance discovery, first discovered at Neyveli by an agriculturist in 1934. Subsequent exploration in Cauvery Basin established a lignite belt about 130km long and 5 to 15km wide, trending NNE-SSW to NE-SW, from Bahur (Officers of Coal Wing, 1988) in the north, through Neyveli, Srimushnam, Jayamkondacholapuram (Mukhopadhyay, 1996) and up to Mannargudi in the south - falling in parts of Union Territory of Pondicherry and Cuddalore, Perambalur, Nagappattinam and Thanjavur Districts of Tamil Nadu. The lignite occurs as a sub-crop at depth ranging from 50m to 500m below ground level. Down dip extension of this lignite zone is reported from ONGC boreholes from 500m to 1800m depth in Tiruvarur, Kamalapuram, Kovilkalappal and Mayiladurai.

Lignite occurs as a sub-horizontal, tabular lensoidal body, sandwiched between the overlying mottled litho units of the Cuddalore Formation and the underlying zone of poorly consolidated thick sandstone (aquifer zone), with minor intercalations of thin ash grey to grey clay and shale.

Lignite zone is 1 to 25 m thick with an average of 12m, north of Kollidam River whereas, 1 to 90 m thick (cumulative thickness) in the Mannargudi area, south of Kollidam River (Kanishkan et al, 1992; Kumaraguru et al, 1997). The estimated reserve of lignite is about 6500 million tonnes and 18,000 million tonnes in the area north and south of Kollidam River respectively (Kumaraguru, 1983; Parthasarathy et al, 1986).

The lignite is coffee brown to brownish black, soft, compact and generally massive. It analyses as follows : moisture 45 to 50%, ash 4 to 6%, volatile matter 23 to 26%, fixed carbon 18 to 21%, calorific value 2500 to 3000K cal/kg and bulk density 1.15 to 1.20.

At present, it is being mined from Mine-I and Mine-II by Neyveli Lignite Corporation Limited in Neyveli area. The mined lignite from mine I & mine II is utilised in thermal plant I&II respectively which has 600 and 1470MW generation capacity.

The age of lignite is now considered as Eocene.

METALLIC MINERALS

Base Metals

(Polymetallic and iron sulphide mineralisation)

Prominent base metal sulphides occur in the Mamandur of Cuddalore District which was explored by geological, geochemical and geophysical methods and exploratory drilling and mining. There are two generations of mineralisation, the first is a multimetal lode comprising zinc, lead, copper, silver and cadmium and the other is a disseminated copper sulphide. The multimetal lode follows the lithological contact (garnetiferous - biotite - sillimanite gneiss) and copper mineralisation is observed in the shear planes on the footwall side. Two ore bodies, sphalerite rich multimetal ore and a chalcopyrite rich one on the footwall side have been delineated. The sphalerite rich ore body extends over a strike length of about 300m with an average width of 3.15m and persists to a depth of 280m along the dip. The reserves in this ore body are estimated to be 0.66 million tonnes with a metal content of 5.53% Zn, 1.15% Pb and 0.45% Cu. The chalcopyrite ore body which extends over a strike length of 180 m with a width of about 7 m and a depth persistence of 34 m, is estimated to contain 0.13 million tonnes of ore with a metal content of 0.62% Cu, 0.69% Zn, 0.12%Pb and 37 g/t Ag.

Lead-Copper-Zinc mineralisation in calc-silicate rocks is traced over a discontinuous strike length of 200m in a 3m wide zone, about 1.6km northwest of Josiyar Alangulam in Madurai District, in the form of streaks, stringers and veinlets traversing calc silicate gneiss, shows up at places on the surface as sparse encrustations of malachite. The mineralised zone is 1 – 4 m. Mineralisation is seen in three thick blocks. An aggregate reserve of 3,61,744 tonnes of ore with 0.4%Cu upto a depth of 40 to 100 m was estimated. Nickel values obtained are poor less than 0.15%.

Near Narayanapuram in Chengleput District, a 380 m long and 5.2 to 9.1 m wide quartz vein was traced in a faulted and fissured zone, carrying specks of pyrite, chalcopyrite and pyrrhotite. Chip samples analyse between 0.4 and 0.04 % Cu.

In Coimbatore District, minor chalcopyrite, pyrrhotite and molybdenite occurrences were noticed in pyroxenite and amphibolite near Godepalaiyam and Maranur.

A shear zone in metanorite near Arumanallur, Kanyakumari District is marked by stringers, veins and segregations of sulphides including pyrrhotite and minor chalcopyrite, molybdenite and pentlandite. Mineralisation is traced over 136m. Samples from a trench assayed 0.12 to 1.04 % Cu and 0.12 to 0.72% Ni.

Bauxite

Irregular lenses and pockets of bauxite / bauxitic laterite occur in the high level laterite cappings over charnockite in the Nilgiri Hills (1920–2530m), Nilgiri District, Shevroy Hills (1535–1649m) (Krishnaswamy, 1958) and Kollimalai Hills (1148–1386m) (Mani, 1977), Salem District and the Palani Hills (1980–2350m), Dindigul District. The thickness and areal extent of the individual occurrences varies widely. In all the areas the laterite is presumably derived by the sub aerial weathering of charnockite and is exposed as patches on the hills. Within the laterite, bauxite occurs as streaks and pockets

extending to different depths. The areal extent of the individual cappings also varies widely.

In Salem District a total of six deposits of bauxite occupying 6 hill tops (hill Nos. I to VI) are known in the Shevroy Hills. The areal extent of the individual deposits ranges from 22,000 sq m (hill No.VI) to 1,55,000 sq m with an aggregate of 4,05,000sq m. The thickness of the bauxite zone is inferred to be 5 to 15 m. The reserves were originally estimated to be about 5.3 million tonnes but Madras Aluminium Company have been exploiting the deposits for more than 25 years and the net reserves now available are likely to be about 2 million tonnes only. The grade is highly variable and the R.O.M. ore is reported to analyse only 40–43% Al_2O_3.

Nineteen bauxite cappings are known from the Kollimalai Hills. Five in Velavanchinadu area; eight in Ariyurnadu area, two in Selurnadu area and four in Tinnanurnadu area. Both primary cappings and detrital spreads around them have been recorded. The thickness of the bauxite varies from 4 to 7m as seen from excavated pits and even more in certain places where the pits have not reached the bottom of laterite cappings. The reserves are estimated to be 3.04 million tonnes. (Al_2O_3 content 35 to 40% - 1.308 million tonnes : 40 to 45% - 1.269 million tonnes : 45 to 50% - 0.456 million tonnes and above 50% - 6000 tonnes.)

In the Palani Hills, Dindigul District, bauxite occurrences have been recorded from Berijam-Fort Hamilton, Konal Ar, Nevadipallam, Pillisulinettu and Kukkal. Konal Ar and Berijam - Fort Hamilton with an areal extent of 324,000 sq m and 41,000sq m respectively are the major ones. The thickness of bauxite ranges upto about 10m. Reserves of about 2.4 million tonnes (2.2 million tonnes from Konal Ar and 0.2 million tonnes from Berijam-Fort Hamilton) with an Al_2O_3 content of 40 – 43% are estimated.

In the Nilgiri District bauxite occurrences can be grouped into three sectors, viz., Kotagiri, Ootacamund and Upper Bhavani. In the Kotagiri sector bauxite deposits are known from hill No. I, II, IV & V of Ilada, Bethal, Taylors Hill, Curzon Valley (hill No.III of Ilada area) and Kerkombai. The total areal extent of the deposits is about 4,00,000sq m the major ones being Kerkombai 2,25,000sq m. Curzon valley 1,35,000sq m and Taylor Hill 30,000sq m. The thickness of the bauxite ranges upto 9m but the quality is poor, below 35% Al_2O_3. The reserves in Kerkombai are placed at about 0.4 million tones.

In the Ootacamund sector, four bauxite cappings, with an aggregate areal extent of 1.71,230sq m in Wenlock Bowns and six cappings with an aggregate areal extent of 1,28,250sq m in Parson's Valley have been recorded. The average thickness is around 4–5m. About 1.05 million tonnes with about 35% Al_2O_3 has been estimated.

Several bauxite cappings, with an aggregate areal extent of 3,86,000 sq m, have been recorded in the Upper Bhavani area. The primary cappings are surrounded by extensive areas of detrital bauxite. Three major occurrences covering a total area of 1,67,500sq m are located in the Lakkadihalla – Talaikund Halla area, and a number of smaller ones over 10,000sq m each, in the Upper Bhavani area. The thickness of the bauxite ranges upto 6m or more and grab samples have analysed 45–50% Al_2O_3.

All the deposits in the Ootacamund sector are located within the protected Nilgiri Bio-Reserve area.

Summing up, the known bauxite resources of Tamilnadu are relatively small, about 10 million tonnes and of low grade, mostly with less than 43% Al_2O_3.

Chromite

Important chromite bearing amphibolite bands which form sill like bodies along the foliation planes of anorthosite - gneiss, are traced over a stretch of 12.8km between Sittampundi and Karungalpatti (between lat. 11Y16' and 11Y18'N and long. 77Y50' and 78Y01'E) in Salem District. The chromiferous amphibolite (chromitites) varies in thickness from 8cm to 3.05 m and contains on an average over 60 % chromite, chemical analysis shows Cr_20_3 21.72 - 28.20%, Al_20_3 24.04 - 41.31%, Fe_20_3 10.20-25.59% and Fe0 10.18-12.20%. The reserves are estimated at 0.221 million tonnes upto a depth of 6.1m. In Coimbatore District three occurrences of chromite have been reported from 1) Karappadi , 2)Mallanayakanpalayam and 3) Solavanur. Chromite occurs as bands, lenses and disseminations in anorthosite bands associated with ultramafic complexes. The chromite bands show variation in length and width. The maximum length and width of the band is 1 km and 250 m respectively. Proved reserves of the order of 6,600 tonnes and possible reserves of about 30,000 tonnes upto a depth of 10m are estimated for the three areas. The grade of the ore is as follows : Cr_2O_3 21.79 to 27.87%, Fe_20_3 23.2 to 28%, Al_20_3 19.19 to 22.81 % and SiO_2 7.82 to 12.02%.

Columbite-Tantalite

Incidence of Columbite-tantalite in pegmatite has been reported from Kurumbapatti and Vairamangalam in Coimbatore District and Mungilkaradu and Sammalai Hills of Kadavur, Tiruchirapalli District.

Gold

Gold occurrences in the Nilgiri District and the adjoining parts of Kerala have been explored. The important mines and prospects include Alpha, RoU.S. Dollaronmalai, Harewood at Devala and Solomon, Richmond, Rosedell, Glenrock and Phoenix near Pandalur. The auriferous quartz veins are 60 cm to 1.52 m thick, exhibiting swelling and pinching structure. Samples collected from the Devala - Pandalur area show a gold content of 3.06 g/t, and at places 'pay shoots' show upto 6.12 g/t in the Harewood mine. The possible reserves of gold in the Skull-Victoria Reef are computed to be 1,603,800 tonnes of ore with an average content of 1.9 g/t.

Old workings for gold within the quartz veins having maximum of 1.9 m thick have been located in the Adadurai tea estate near Kotagiri. The groove samples showed mostly less than 1ppm gold, but there were a few high values, the highest being 18.3ppm.

The Kolar Schist Belt of Karnataka extends into the Veppanapalli area, Dharmapuri District, Tamil Nadu. The Adakonda and Maharajakadai blocks have been explored in recent years by GSI. The country rock mainly comprises amphibolite and quartz - felspar - biotite gneiss with banded magnetite quartzite, silicified zones and quartz veins. Exploratory drilling in Maharajakadai block has indicated a potential reserve of 67,095 tonnes of ore with gold content of 1 to 2 g/t upto 75 m vertical depth spot values going upto 100 g/t. In Adakonda block, surface exploration indicates 0.2 to 2.57g/t of gold over an average width of 1.5m over a strike length of 450m (Suthanandam et al, 1989).

Iron-ore (Magnetite-Quartzite)

A number of magnetite-quartzite bands of variable thickness and length are known from different part of Tamil Nadu, especially north of the Kaveri River. Some of the prominent deposits have been investigated by mapping and sampling. A total reserve of over 500 million tonnes with an average

grade of 38% iron is estimated for the major deposits occurring in Salem, Vellore, Tiruvannamalai, Villupuram, Dharmapuri, Thiruchirappalli, Namakkal and Perambalur Districts.

In Salem District, a number of magnetite-quartzite bands including the large deposits at Kanjamalai and Godumalai have been explored. In Kanjamali Hill, three main bands and a few subsidiary bands occur. The lower most band of the three, with an average thickness of 18.3 m is trace over 17.7 km. The middle and upper bands are 7.6 m thick and 9.6 km in length each. The reserves upto a depth of 30.5 m are estimated to be 35.6 million tonnes for the lower most band, 8.1 million tonnes for the middle; and 8.1 million tonnes for the upper band. The subsidiary bands, a total length of 1.6km and an aggregate thickness of 22.9m are estimated to contain 7.1 million tonne upto 30.5 m depth. Total reserves in Kanjamalai are put at 55.52 million tonnes upto a depth of 30.5 m with an average iron content of about 35% and low P_2O_5, TiO_2 and Al_2O_3. The iron ore bands persist to much greater depths and the potential resources in the basal band and in the two upper bands are of the order of 100 million tonnes and 75 million tonnes respectively, upto a depth of 120 m.

Several iron ore bands 3 to 5m thick are known from Godumalai. Reserves are placed at 12.65 million tonnes upto a depth of 30.5m and the potential resources at 60 to 70 million tonnes. Smaller bands are known from Godumalai -Tainandarmalai in Attur Valley, Kollimalai, Talamalai, north and south of Namakkal and Pachaimalai. A band with an average width of 5 m extending over a length of 7km has been traced upto north of Vadavattur. The aggregate reserves in the above bands are 144.1 million tonnes. Magnetite-quartzite bands of varying length and thickness are traced near Sittilingi, Malathangi, Tumbal, Alangadu, Suryagaddi and Puduvalavu in Salem District. The total probable reserves of ore with 35-37% iron content are computed to be 8.2 million tonnes upto a vertical depth of 30m. Two magnetite quartzite bands with a cumulative strike length of 4.2 km and an average thickness of 25m have been traced near Nainarmalai. The reserves are estimated at 7.8 million tonnes with 30 - 37% iron. In the Villiyanpampatti, Tattayyangarpettai area, five bands ranging in thickness from 3 to 50 m have been intermittently traced over a length of about 40km.

The Thirthamalai deposit in Dharmapuri District is estimated to contain 35 million tonnes of ore upto a depth of 60 m, the average ore content being 36.7% Fe and 0.14 to 0.196% P_2O_5. The northern extension of the Thirthamalai deposits and the band in Alambadi are estimated to contain 2.09 million tonnes of ore.

In Villupuram District, a magnetite-quartzite band was traced northwest of Manmalai and between Budamangalam and Talankunam and a total reserve of 0.345 million tonnes of ore was estimated, analysing 36.40% iron and 40.48% silica. Magnetite quartzite bands analysing 52% Fe_2O_3 and 47% SiO_2 occur to the west of Seshasamudram, Nedumanur and Poykkunam. A total reserve of 0.508 million tonnes has been estimated.

In Tiruchirappalli District, magnetite-quartzite bands have been traced near Valasiramani and total reserve of 37.8 million tonnes of ore have been estimated upto a depth of 30m. A 12.2m wide and 4.8km long magnetite-quartzite band located to the north of Mahadevi contains 0.64 million tonnes of iron ore (32.10 - 41.32% Fe) upto a depth of 30 m. A 6.1m wide and 0.5km long band near Malamutti was estimated to contain 0.05 million tonnes of low grade

iron ore (23-37% Fe) upto a depth of 6m.

In Tiruvannamalai District, banded magnetite-quartzite with hematite has been recorded 12km northwest of Tiruvannamalai in Kavuthimalai, Vediappanmalai and south of Ponakkadu. The iron ore band was investigated by the State Department of Mines & Geology with the aid of U.N.D.P.(1977). The band occurs as three detached synclinal basins on either side of the Tiruvannamalai - Kanchi road with converging dips of 65Υ to 80Υ. Its strike length in the three basins varies from 2.5 to 4.5km. According to the State Department of Mines & Geology of Tamil Nadu, the inferred reserves are

Vediappanmalai	—	60 million tonnes
Kavuthimalai	—	56 million tonnes
Uchchimalai	—	20 million tonnes

Twentyone drill holes have also been completed by them in Kavuthimalai iron ore band.

Pelletisation of magnetite quartzite ores of Kanjamalai and Kavuthimalai was studied by U.N.D.P. (1977). Iron ores of Tiruvannamalai are found to be amenable for pelletisation. The bench scale tests have established the feasibility of producing green pellets with 65.4% total iron 87.43% Fe_2O_3 and 5.89% FeO, which can be directly reduced to yield sponge iron with 90.14% total iron.

Molybdenum

In Tamil Nadu, molybdenite mineralisation occurs in two different geological settings - one associated with the alkaline group of rocks occurring in Dharmapuri and Vellore Districts of Northern Tamil Nadu and the other in a graphite pegmatite intrusive into migmatitic gneiss of Karadikuttam area of Dindigul District.

The northern molybdenum province extends in a NNE-SSW direction over a strike length of about 200 km from Gudiyattam in the north to Bhavani in the south with a width of 40-50km. Epidote-hornblende gneiss showing compositional variation from granodiorite to quartz-diorite is the dominant rock type. This belt has witnessed widespread alkaline magmatism during Neo-Proterozoic with the emplacement of four major syenite-pyroxenite-carbonatite complexes such as Elagiri, Koratti, Samalpatti and Pakkanadu. Several mafic dykes predating this alkaline complex are found within the epidote-hornblende gneiss and its precursor charnockite.

A number of NNE-SSW trending shear zones are seen in this lithotectonic belt and molybdenum mineralisation is confined to the quartz veins emplaced within this shear zone as well as in the sheared and sericitised host gneiss on either side. Molybdenite occurs as fine flakes, fine granular aggregates and disseminated grains and occupies the hair-line fractures in the quartz veins.

Harur-Uttangarai Belt : Dharmapuri District

Preliminary investigation by GSI has brought to light a NNE-SSW trending shear zone with incidence of molybdenum and galena in SE part of Dharmapuri District (Rao, 1991). The shear zone extends over a strike length of 24km from Velampatti in the south to Uttangarai in the north separated by Ponnaiyar River. Yet another parallel shear zone, 4 km in extent has been identified in the Vellakkal Reserve Forest i.e. north of Ponnaiyar River. The mineralisation is confined to the shear zone within which emplacement of quartz and carbonate veins are present. The mineralisation is both in the veins as well as sheared altered country rock.

In Velampatti South Block, detailed work was

carried out by drilling upto the fourth level over a length of 1.38 km, which proved the depth persistence of molybdenite mineralisation upto the vertical depth of 320m. The resources estimated in this block are of the order of 2.74 million tonnes with an average grade of 0.102% Mo at 0.03% cut-off or 5.75 million tonnes of ore with an average grade of 0.064% Mo at 0.01% cut-off. In the other blocks of Harur sector, a tentative resource of 12.68 million tonnes of ore with an average grade of 0.032% Mo has been estimated (Singanenjam et al, 1994).

In the Velampatti Central Block (Palanisamy et al, 1997), the extension of the above said mineralized zone has been proved further north over a strike length of 0.50km. A reserve of 0.336 million tonnes with an average grade of 0.079% Mo at 0.05% cut-off and 0.723 million tonnes with the average grade of 0.059% Mo at 0.03% cut off is established. The other nine blocks existing north of Ponnaiyar River in Uttangarai Sector are being explored, some of the borehole core samples show values as high as 2000 ppm of Mo.

Alangayam : Vellore District

The Alangayam area falls in the northeastern part of the Gudiyattam Bhavani Belt and mainly consists of epidote - hornblende gneiss occupying the valley between the Yelagiri Hills in the west and the Javadi Hill range in the east. A number of quartz - baryte vein bearing pyrite, galena and molybdenite and occasional chalcopyrite are emplaced within epidote - hornblende gneiss. Detailed prospecting including scout drilling by GSI, has revealed a number of low dipping parallel quartz veins, some of which assayed significant molybdenum values (0.01% to 0.51%). The maximum thickness of the mineralised zone is one metre. A probable reserve of 86,314 tonnes and possible reserve of 6,33,408 tonnes with the average ranging from 0.0125 to 0.04% of Mo has been estimated.

Karadikuttam : Dindigul District

Near Karadikuttam in Dindigul District, molybdenite occurs in the form of disseminated and thin stringers in a graphite pegmatite, intrusive into migmatitic gneiss. Exploratory drilling has established about 0.28 million tonnes of ore with average grade 0.0285% of Mo.

Nickel Ore

The weathered profile over the Bhuvanagiri Ultramafics, Coimbatore District has yielded 0.10 to 0.43% Ni. Peridote / dunite from Chalk Hills, Salem District has yielded upto 0.40% Ni and occasional composite grains of Pentlandite + Pyrrhotite + Chalcopyrite have been recorded from the Red Hills. Nickel values upto 0.12% have also been recorded from the Torappadi ultramafic body, Vellore District.

Tin-tungsten

Disseminations, streaks and patches of scheelite are seen in the calc-granulite band occurring within pegmatoidal granite/granite body in the Karungalagudi area, Madurai District. Significant concentrations, upto 2% W, are seen near Kambalipatti, Somagiri and Rayarpatti . At Kambalipatti, the mineralised zone has been traced over a strike length of about 270m with a width upto 40m. In the Somagiri also the mineralised zone as a width of about 40m or more and is inferred to have a strike length of about 1km. Several ore shoots (at the cut-off grade of 0.05% W) are inferred. On the basis of trench sampling 4 or 5 ore shoots upto 5 m wide are inferred. Ore shoots are estimated to comprise about 20 to 30 % of the total width of the mineralised zone and are expected to have an average W content of 0.10 to 0.15%. In the Rayarpatti area, the mineralised zone extends over a strike length of about 1800m but the mineral content is rather low, about 200 to 300 ppm.

Tin values (upto 1800ppm) are associated with the mineralised zone in the Kambalipatti. Tin values of 200 to 500 ppm are reported from three grab samples of quartzite from Vaiyampatti, Tiruchirapalli District.

NON METALLIC AND INDUSTRIAL MINERALS

Apatite and Rock Phosphate/ Phosphatic nodules

Phosphatic nodules occur in association with gypseous clay and shale of Karai Formation of Uttattur Group of Cretaceous age, along a belt extending from Neykulam to Siruganpur covering an area of 27.5km in Tiruchirapalli District. A total probable reserve of 127,000 tonnes of these nodules upto a depth of 15.24m was estimated. The P_20_5 content of the nodules varies from 21.14 to 26.50%. Upto 1960, about 100 to 150 tonnes of nodules were produced annually, but no production is reported at present.

Small crystals of apatite have been noted in hybrid rocks (syenite-pyroxenite) in the Hogenekal area, Dharmapuri District (Srinivasan et al, 1972). In the carbonatite near Sevattur, Vellore District, apatite crystals are disseminated and a reserve of 190,000 tonnes of apatite has been estimated with P_20_5 content of 27.48 per cent.

Asbestos

Amphibole asbestos has been noted near Bargur and Muddampalayam in Coimbatore District, 13km south of Namakkal and Allanganathan in Namakkal District and at Kargudi in Karur District. These occurrences are of limited extent hence not economical.

Barytes

Barytes occurring as lenses in pegmatites occurs near Kurichchi, Coimbatore District. The mineral is associated with quartz veins near Alangayam, Vellore District. The veins are irregular and the cost of winning is considered of barites costly because of the intimate association with quartz.

Beryl

Crystals of beryl occur in pegmatites at the following localities : i) 3.2km WSW of Idappadi, ii) 0.8km east of Kurumbapatti, iii) 6.4km west of Bhavani, iv) 0.8km east of Vairamangalam, v) 1.2 km NNE of Muddampalaiyam, vi) 1.2km NNE of Battadapuram, vii) 12km north of Govanur, viii) 4km SSW of Kavundanur, ix) Padiyur, x) Muttanchetty, xi) SW of Kavakkarapatti in Salem District, xii) Sukkampatti, xiii) Valasiramani in Tiruchirapalli District, xiv) Dumanur in Coimbatore District.

Celestite

Thin irregular veins of celestite 3 to 10 cm thick are sparsely distributed in the clay of Uttattur Group near Neykulam, Periyakurukkai and Sirukanbur, Tiruchirapalli District. Commercial exploitation is not considered feasible because of the sparse and irregular nature of the occurrence.

Clays

Clay deposits of different grades occur in Nilgiris, Thiruvallur, Cuddalore, Tiruchirapalli, Tirunelveli and Sivaganga and Pudukottai Districts. The clays are of two types. i) residual clay and ii) sedimentary clay.

In Nilgiri District near Cherambadi residual clay associated with altered pegmatite has a reserve of 25,000 tonnes. In Cuddalore District near Kumalampattu RF and in Villupuram District at Tiruvakkarai, weathering of Archaean gneiss has given rise to kaolinitic clay with an estimated reserve of around 4 million tonnes.

Sedimentary clay occur in Cuddalore, Thiruvallur, Sivaganga, Pudukottai and Tiruchirapalli Districts.

Gondwana clay suitable for stoneware manufacture occurs over 2.59 sq km in Sivaganga in Sivaganga District with a reserve of 4.06 million tonnes. A large number of clay deposits from the Gondwana formations are recorded in Thiruvallur District at Vallam, Mathur, Vaiyupur, Edapalaiyam, Kannanthangal, Kommanthangal, Kelacheri, Mappadu, Sattarai, Kalambedu and Kannur. The reserves are estimated at 12.9 million tonnes of which 10.5 million tonnes are of refractory grade. Low refractory clay occurs in Tiruvallur Taluk of Thiruvallur District with an estimated reserve of 12.43 million tonnes.

Upper Gondwana clay (Lower Cretaceous) upto 7.5m thick, occurs as six detached patches near Karai, Tarani and Uttattur. The clay has high alumina content and does not fuse at 1300°C. Reserves are estimated at about 0.6 million tonnes.

Tertiary clay occurs associated with sandstone of Mio-Pliocene age in Neyveli and Panruti areas in Cuddalore District. In Neyveli there are three horizons of clay, both of fire clay and ball clay varieties. The clay underlying lignite is very plastic and can be termed as ball clay. The total reserve of clay in Neyveli occurring over 14 sq km is estimated at 13 million tonnes. Fire clay occurs south of Panruti as at lensoid deposit in Cuddalore Formation with an estimated reserve of about 5 million tonnes. The alumina content varies from 20-30%. Small clay deposit occurs in Tertiary sandstone near Aranthangi in Pudukottai District having an reserve of 70,000 tonnes with alumina content of about 27%. They are low refractory grade.

In Pondicherry, white to grey ceramic clay with 75% to 90% clay content is met within boreholes near Nettappakkam, Panaiyadikuppam, Kadavanur, Nonankuppam, Avispakkam, Pillaitottam, Kil Avinjipattu, Viranam, Bahur and Seliamedu. Commercial exploitation may not be feasible due to a shallow water table and high overburden.

Corundum

Corundum occurrences in anorthosite at Sittampundi, Salem District is known since long and exploited over 50 years. Recently, on the basis of pitting carried out over an area of 712,750 sq. m a total of 15,400 tonnes of reserve is inferred upto a depth of 10 m. Minor corundum occurrences are known from Coimbatore District.

Corundum occurs as discontinuous lenses and pockets in a 65km long and 8km wide belt from Donnakuttahalli in the south to Chinatalagutta in the north. The mineral occurs in three types of rocks, viz., (a) pure pegmatite, (b) syenite and (c) metamorphosed charnockite or gneiss. It is also found in small quantities as detrital material in soil or wastelands in the neighbourhood of Palakodu and Papparappatti in Dharmapuri District.

Anorthite – gneiss bearing nests and pockets of corundum extend as an arcuate belt, E - W trending 24 km lens and upto 2.4 km wide from Pattalur in the west to Kottakkalpalayam and beyond in the east.

Construction Material (including Dimension Stones)

Greater part of Tamil Nadu is occupied by hard crystalline rocks. These as well as some of the clays are used as construction materials for various purposes. The hard rocks are normally used as dressed stones, ballast and jelly in various parts of the state. In recent times stone crushing units have come up on large scale, catering to the high demand for road metal and railway ballast requirements.

Developmental activities in respect of dimension stone deposits such as exploration,

exploitation, processing and export is so advanced in Tamil Nadu, it merits distinct entity and narration. Practically every major lithotype of the Precambrian shield is formed a dimension stone variety, finding extensive use in building the industry.

While basic charnockite in areas around Namakkal, Namakkal District and Perambalur, Perambalur District is utilised as *OLIVE/SEA GREEN* or *SEAWEED GREEN*, its intermediate and acidic members along with their migmatised/ granitised components constitute a suite of blue based dimension stone variety popularly called as *BLUE MULTI* in areas around Rasipuram, Salem District, Turaiyur and Sikkathambur, Tiruchirapalli District. The associated rock type Leptynite in Melur, Madurai District is marketed as *KASHMIR WHITE* wherein the visual display of garnet in the pure white quartzo-feldspathic matrix is appealing and aesthetic. The transition zone from amphibolite facies metamorphism in the north to granulite facies in the south in the vicinity of Krishnagiri, Dharmapuri District is marked by an uniquely designed, pink granite-gneiss which has become the world famous *PARADISO*. The granite-gneiss of Peninsular Gneissic Complex with its diverse composition, colour, texture and degree of assimilation of basic enclaves has contributed immensely in the exploitation of several varieties such as *COLUMBO/ TROPICAL JUPARANA* in Togamalai, Tiruchirapalli District and Kunnamalai, Salem District, *RED WAVE* in Jakkeri, Dharmapuri District and *ENGLISH TEAK* in Kannukaranur, Dharmapuri District. Augen gneiss with its porphyroblasts of grey/white feldspar is *ZEBRA WHITE* in Mayilkalpalaiyam, Salem District and with pink feldspars, *TIGER SKIN* in Sekkadipatti, Madurai District. Younger intrusive granite with weak to moderate foliation and colour range from grey/yellow to pink forms dimension stone deposit such as *RAW SILK, VANJI PINK, GREY PEARL, MOON STONE, TOMATO/CHILLI RED,* etc., in localities, Vedasandur, Dindigul District, Vanjinagaram, Madurai District, Tiruttani, Tiruvallur District, Sholingur, Vellore District and Govindampalaiyam, Salem District. The coarse-grained, mostly porphyritic / glomero-porphyritic Gingee granite has the trade names *DESERT BROWN* and *HONEY DEW*. The pure white (uncontaminated from subsequent pink feldspar permeations and venations) pegmatoidal granite of Idappadi, Salem District is recognised world over as *TIPPU WHITE*. Its contamination with pink feldspars is produced *ROSA VERDE, SUMMER SKY* and *SAMANTHA PINK* in the same area. The augite-nepheline syenite of Sivanmalai, Erode District has carved a segment of its own in the international market as *GREEN ONYX*.

In addition to prolific occurrence of mutti coloured granite deposits, Tamil Nadu is also endowed with high and medium quality black granite deposits around Tindivanan, Villupuram District, Attur, Salem District, Dharmapuri and Harur, Dharmapuri District. Each black granite material, especially from Kunnam (KNM black), Villupuram District, Bevanur (BVR) Dharmapuri District, Paithur (PTR), Salem District and Yellikaradu (YKD), Salem District is named after the locality and exported overseas. Of these, the Kunnam *(KNM) BLACK* is equivalent to the *JET BLACK* or *ABSOLUTE BLACK* of Sweden wherein the inherent characteristics such as densely clouded plagioclase feldspar, unaltered pyroxene (augite and pigeonite) and appreciable incidence of opaque accessories have all contributed to the absolute blackness of the material which attains glossiness and reflectivity of very high order on polishing.

Depending upon quality, colour, size of blocks and quantum of supply, the export price of coloured granites varies between 450 U.S. Dollar and 900 U.S. Dollar per cum. FOB port; while black granites have price range between 800 U.S. Dollar and 1800 U.S. Dollar per cum. FOB port. Total, probable resource estimate of dimension stone granites during Phase I investigation (1992-97) is around 23.62 million cu m. The projected minimum export of around 250,000 cu. m. in the next five years is likely to bring in foreign exchange of about 120 million U.S. Dollar (Rajaram et.al. 1999).

Feldspar

Numerous pegmatite veins with feldspar have been traced in Coimbatore, Salem and Tiruchirapalli Districts. In Coimbatore District, pink feldspar upto 78 x 38 x 25mm derived from pegmatites traversing biotite gneiss occurs in (1) the plains surrounding Kattanumalai (2) in the plains southeast of hill Δ2608, forming the northwestern extension of Kattanumalai and (3) in the vicinity of Pasumani and Manguli. Host pegmatite veins are generally short and narrow but a few extend over about 1 km and are 15 to 22 m wide. In Salem District, pegmatites with pink potash feldspar are located near Jalakandapuram, Kuppamatti, Nangavalli and Oravappatti. In Tiruchirapalli District, a number of pegmatites are being worked for feldspar around Manapparai. Other important occurrences are near Odaiyapatti and Kadavur.

Gemstones

Sporadic and irregular crystals of emerald, aquamarine and amethyst occur in a few localities in Coimbatore District. Local workings for moonstone in pegmatites near Vanjipalaiyam and a few other localities is reported. The State Department of Geology & Mines reported semi-precious stones like amethyst, aquamarine and moonstone from pegmatites near Kangayam, Chennimalai and a few other localities in Erode District. In Madurai District, ruby and sapphire are collected from a disused well. The cordierite occurrence near Kiranur in Karur District is not considered rich enough for working. Disseminated crystals of ruby are recorded in sillimanite schist near Sakkaraikkottai in Tiruchirapalli District. Chrysoberyl occurs in pegmatite in Tadakarakonam in Kanyakumari District and Kalakkadu Hills in Tirunelveli District. Gem quality ruby is associated with anorthosite near Karungalpatti in Salem District.

Graphite

A major graphite occurrence of Tamil Nadu is located in Puvandhi in Sivaganga District over a strike length of 11 km. Reserves are estimated at 5 lakh tonnes of graphite concentrate upto a depth of 15m with 15% fixed carbon. Depth persistence upto 100m is established by drilling. In the western segment of this 11 km stretch, a resource of 75,000 tonnes of graphite with F.C. upto 10.9% has been inferred upto a depth of 15 m over a strike length of 5.25 km (Kothandam et al, 1994; Manavalan et al, 1995)

Minor graphite occurrences are located in Kurinjankulam in Tirunelveli District with a reserve of about 19,000 tonnes, on Palakottai Hill and near Pudupalaiyam in Vellore District with an indicated reserve of 2,600 tonnes, and in Tirumangalam , Ponnamangalam in Madurai District having a reserve of about 17,000 tonnes.

Gypsum

The most important deposits of gypsum occur in Perambalur Taluk in Perambalur District and

Lalgudi Taluk inTiruchirapalli District,in the badland region between Chittali in the north, Tappay and Periakurukkai in the south, over an area of 56sq km with interbedded clay. Reserves are estimated to be of the order of 15.60 million tonnes.

In Tirunelveli District, gypsum associated with kankar is reported from a few localities. In the saltpans, located along the east coast between Veppalodai and Ayyanapuram, gypsum is won as a by-product.

In Coimbatore District, gypsum occurs as lumps with a kankar core in black cotton soil (Gopalakrishnan, 1985) in Gomangalam Pudur Kulanayakkanpatti, east of Pusaripatti, south of Jakkarpalaiyam and Kattanpatti.

Ilmenite, Rutile, Monazite and Garnet sands

In Kanyakumari District, heavy mineral concentrations in beach sand occur as detached patches along the east coast between Kolachal and Kanyakumari over a distance of about 75km. A total of 45,75,605 tonnes of heavy mineral concentrates have been estimates by the Atomic Minerals Division on the beach between Thingattanam and Illinjam, Midalam and Kolachal, Kolachal – Manavalakurichi, Vajakkalurollankodu, Chinnavillai-Manavala-kurichchi, Periakattuthurai-Manakkudi and from Manakkudi to Kovakulam in Kanyakumari District. The sands between Lipuram to Vattakottai consist about 65-70% ilmenite, rutile and monazite. Reserves of ilmenite/rutile are estimated at about 15,200 tonnes and of monazite about 311 cubic metres.

Black sand concentrates have been traced continuously over a stretch of about 7km from the mouth of Valliyar River to Colachal in Manavalakurichi and beyond. The deposits contain on an average 45 to 55% ilmenite, 2-3% rutile, 7-14% garnet, 3-4% monazite, 4-6% zircon, 2-3% sillimanite, 0.5-1% leucoxene and other minerals including silica 10-25%. The Indian Rare Earth Ltd., has placed the reserves at 4.70 million tonnes of ilmenite and 0.08 million tonnes for rutile. These deposits are being exploited by the IRE Ltd.

The sands between Lipuram to Vattakottai on the east coast consist about 65-70% ilmenite, rutile and monazite. Reserves of ilmenite / rutile are estimated to be about 15,200 tonnes.

In the Union Territory of Pondicherry, Ilmenite and garnet sands occur as irregular patches over a length of 19km and width varying between 20 to 124 m along the coast of Karaikal. The Atomic Mineral Division has estimated 17,26,862 tonnes of heavies in this area. A total indicated reserve of 1,08,300 tonnes of ilmenite has been estimated upto a depth of 1.50 m. for the Melvanjiyur - Tirumalarajanpatnam area. In the Akkaraivadi area, a total indicated reserve of 49,630 tonnes of ilmenite has been estimated upto a depth of 1.5 m.

In Ramanathapuram District, limited stretches of garnet-ilmenite sands occur at Valinokkam, Kilakarai, Periyapattanam, at the mouths of the Virisuli and Pambar Rivers along the northern beaches of Rameswaram island, Pattukidapattanam, Vattanam and Pudupattanam. Heavy mineral concentrates upto 93,60,093 tonnes have been estimated by the Atomic Minerals Division between Periaswamipuram and Vembar Naripaiyur in Ramanathapuram District.

In Nagapattinam District, intermittent occurrences of heavy mineral sands have been recorded between Nagore and Tranquebar over a stretch of about 24km. and again over a 12 km stretch in the Tranquebar – Ambanar – Poompuhar - Pudupuram sector. The concentration of heavy

minerals is relatively better in the Tranquebar - Ambanar sector over a 3.2 km distance. The bands of good concentration are thick from 1.25 to 2.5 cm thick and upto 30 m wide. The concentration of ilmenite is only about 8%, rutile and zircon below 0.5% and monazite about 1.5%. Appreciable incidence of pyriboles (23.92%) tends to interfere with the separation of ilmenite.

These deposits have a probable reserve of 90,400 tonnes of ilmenite and 4,900 tonnes of garnet.

Other small occurrences are (1) between Mimisal and Adirampatnam, (2) Tirumullaivasal and (3) at the mouth of Coleroon.

Ilmenite rich beach sands occurring to the east of Kodiyampalaiyam extend over 2km the average width being 50 m. The percentage of ilmenite in a sample was found to be 41.6.

In Tuticorin District, out of several deposits of ilmenite-garnet sands the best are at the mouths of Vaippar and Kallar, where they extend over a length of 3.2 to 4.8 km and upto 122 m wide from the high water mark. The probable tonnage of the Vaippar - Kallar deposit is: ilmenite 32,500 tonnes and garnet 9,650 tonnes. Red garnet sand occurs between Nambiyar and Uvari and south of Navaladi. The proportion of garnet is 75% in the rich deposits and about 45% in the surface sands. The total reserves of garnet sand are about 76,000 tonnes.

Local concentrations of ilmenite sands are known near Vijayapatti and Kuttankuli. About 406 tonnes of ilmenite are likely to occur in the bed of Modambakulam tank, Tiruchendur Taluk.

Good patches of ilmenite sands also occur at Taruvaikkulam, which extend over 3.2km. The belt containing good concentrates varies from 1.5 to 30.5 m in width.

Concentration of heavy minerals has also been estimated to be in the order of 26,41,032 tonnes in Uvari - Navaladi - Athangarai beach deposits.

Limestone

Limestone in Tamil Nadu occurs as crystalline and non-crystalline (amorphous) varieties besides corals. The bulk of limestone deposits are found to the south of Moyar – Bhavani - Attur Lineament and thus the southern districts form the limestone province (Srinivasan, 1974). The crystalline limestones of Precambrian age are mainly distributed in parts of Salem, Tiruchirapalli, Karur, Madurai, Virudhunagar, Ramanathapuram, Nagapattinam, Tirunelveli, Tuticorin and Coimbatore Districts. The total reserves of crystalline limestone are 200 million tonnes of 'Proved' category and about 25-30 million tonnes of 'Inferred' category. Non-crystalline limestones are located in parts of Tiruchirapalli, Tirunelveli and Tuticorin Districts. The total estimated reserve of non-crystalline limestone is about 670 million tonnes of both 'proved' and 'inferred' categories of which 650 million tonnes of Cretaceous age distributed in erstwhile Tiruchirapalli District while rest are of Tertiary age distributed in Tirunelveli District. Coral limestone is found in a series of islands in Gulf of Mannar, Palk Bay and Rameswaram. Mining of coral limestone is banned at present to preserve ecology and to prevent sea erosion. Some of the better-known occurrences are described below.

The total reserves of crystalline limestone are 200 million tonnes of 'Proved' category and about 25-30 million tonnes of 'inferred' category.

In Namakkal and Salem Districts several crystalline limestone bands occur in Sankari, Tiruchengodu and Namakkal taluks. Many of them have been assessed by the Neyveli –Salem Steel Project, the State Department of Geology & Mining

and Geological Survey of India.

In Pallakkapalaiyam area, there are two parallel bands extending over strike lengths of about 700m and 1,500m with average widths of about 135 m and 60 m respectively. The reserves are estimated at 7.31 million tonnes. Near Varanalpalayam, a 2.4km long band ranging in width from about 15 m to 240 m is estimated a reserve of 15.24 million tonnes upto 30 m depth. Limestone reserves in the nearby Devannagavundanur and Chinnagavundanur are estimated to be 6.63 million tonnes.

A 1 km long and 30 m wide band occurs near Mottaiyanur. Reserves in this band are estimated at 13.2 million tonnes. Limestone bands with a synclinal deposition are seen near Mulakkattanur. The main band extends over a strike length of about 2km and ranges in width from 75-300m. The reserves of limestone of good quality with about 45% CaO are estimated to be about 13 million tonnes.

A limestone band 30 – 90 m wide extends over 2 km on either side of the 258th milestone on the Sankaridurg - Bhavani road. Reserves of 5.08 million tonnes upto a depth of 15m have been computed for this band.

Bands occurring near Karuveppampatti, Kolikalnattam and Vakkalipatti are estimated to contain 2.49 million tonnes of cement grade limestone. Several relatively small bands in Namakkal Taluk are estimated to contain a total reserves of about 3.09 million tonnes.

Several lenses of high grade limestone of relatively small dimensions (strike length upto 300m and widths of less than 10m mostly) are also reported from the Tiruchengodu and Namakkal taluks, Namakkal District. The larger ones occur near Kulingipalayam on Sankaridurg - Bhavani road, Malappalaiyam, Annadanapatti, on Tiruchengodu - Namakkal road and Salaippalaiyam. The reserves aggregate to about 8.5 million tonnes.

Occurrences of high grade limestone near Ramadevam, Nadandai, Sirapalli and a few other localities in Namakkal Taluk are estimated to contain about 0.37 million tonnes.

In Tiruchirapalli District, six million tonnes of cement grade limestone have been estimated in Thachankurichchi Reserve Forest, Kalpalaiyam.

In Karur, Kulithalai and Vedasandur taluks of Karur and Dindigul districts, limestone occurs as 1) 10km long folded band between Gejjalampatti and Kallampatti. This band is being mined by M/s. Chettinad Cements Limited 2) A major 30km band trending in a WNW-ESW from west of Palaiyam to Ayyampalaiyam. Reserves are estimated at 76 million tonnes. Important deposits of more than one million tonnes are Devarmalai, Mamarathupatti, Samipuliyur, Tettampatti. In all total, reserves in Karur and Dindigul Districts are about 94.75 million tonnes of cement grade limestone.

In Madurai District, about two million tonnes of crystalline limestone occurs in Elaiyarpatti and about 0.2 million tonnes in Thirumal.

Low grade limestone of about 2.47 million tonnes occur in Bodinayakkanur in Theni District.

In Coimbatore District the total reserves of crystalline limestone from Madukkarai including Ettimadai and Walayar deposits are about 28 million tonnes with 46 to 53% CaO, 0.84-4.6% MgO, 2.87-16.57% SiO_2. Minor occurrences of limestone are reported in Pollachi and Erode taluks.

In Tirunelveli and Tuticorin Districts, bulk of limestone for cement industry comes from Ramayyanpatti, Talaiyuthu, Pandapalli, Sattankulam and Eluvaramukki - Pidaneri and Kayathar areas

(Narayanaswamy, 1944; Narasimhan, 1961). The total reserve is about 20million tonnes with average CaO 45%, MgO 6% and SiO_2 8%.

Reserves in bands near Puvandi, Sivagangai District are estimated to be 0.5 million tonnes.

Three bands of good quality limestone ranging in strike length from 1.5 to 6.5 km and upto 75 m wide occur near Pandalkudi, Palavanattam and Chinnayapuram of Virudhunagar District. Reserves in these deposits are estimated at about 17.20 million tonnes. In the Alangulam area, Virudhunagar District, three bands of good quality limestone extend over a strike length of upto 2.5 km. The reserves in these bands upto depth of 10 to 15 m are of the order of 6.31 million tonnes.

In Tiruchirapalli and Perambalur the non-crystalline limestone deposits occur over an area of 400 sq km in Cretaceous and Paleocene sediments between Coleroon in the south and Vellar in the north. All along the western contact with the Archaeans there are number of small but scattered deposits of reefoidal limestone of Cretaceous age starting at Oalaippadi in the north to Tirupattur in south. In between, reefoidal limestone occurs at Kallai, Paravay, Pudur, Andur, Maruvattur, Kalpadi, Varugapadi, Karai, Terani, Neykulam and Tirupattur. Along the southern boundary of the Cretaceous rocks reefoidal limestone and other clastic limestones are found near Dalmiapuram in the villages of Pullambadi and Kallakudi. Further northeast of Dalmiapuram, limestone is found around Kilpaluvur in the Sillakkudi Formation of Ariyalur Group occurring in juxtaposition with the crystalline rocks of Archaean age. The limestone extends over a strike length of 6 km. with an outcrop width of 200 to 700 m. Potential reserves are likely to be above 6 – 8 million tonnes. Analytical data indicate CaO content of the order of 40 – 45% and R_2O_3 content of 4 - 6%.

Good reserves of fossiliferous limestone occur in the Kallankurichchi Formation of Ariyalur Group, which extends over a strike length of about 30 km from Marudiyar River in the south to Kulumur (Vellar River) in the north. The formation consists of two-limestone members viz., upper and lower separated by sandstone. The upper member is 2.7 to 10.7 m thick with an average thickness of 5.43 m. The lower member is 1.45 to 10.22 m thick but is of inferior quality except a strike length of about 2.1 km in the southern extremity. A total reserve of about 63.37 tonnes has been estimated.

Limestone also occurs in the Niniyur Formation of Palaeocene age which extends over a strike length of about 23 km in two stretches viz., between south of Anandavadi and near Mattur over a strike length of about 12.1 km and between Tamaraipundi and Saundaricholapuram over a strike length of about 5.5 km. The cumulative strike length works out to 17.6 km. The width of the formation ranges from 300 to1000 m with an average of 800m.

Limestone occurs as bands and lenses, the individual bands being 1 – 4 m thick, with the thickness and quality improving from south to north. Total reserves estimated in Niniyur Formation are of the order of 434.107 million tonnes with CaO percentage of 42.6 %.

Regional exploration undertaken in recent years of Cretaceous / Paleocene formations in Ariyalur has resulted in identifying reserves of 531.009 million tonnes of limestone with an average CaO of 45.72% in Kallankurichchi and Niniyur formations. One of the unique features of sedimentary limestone is that it is free from undesirable elements like phosphorous,

sulphur, magnesium and iron within tolerable limits.

Around Karasur, west of Pondicherry, limestone occurs intercalated with calcareous sandstone of Palaeocene age in a NE-SW belt. The thickness of individual bands varies from 0.10 to 1.4 m. Reserves of 2.68 million tonnes of cement grade (45 to 46% CaO) and 11.67 million tonnes of low grade (36 to 40% CaO) limestone have been computed over an area of 6.43 sq km. upto a depth of 8 m. To the east of Sedarapattu, fine to medium grained arenaceous limestone occurs as thin bands intercalated with calcareous shale. The estimated reserves are of the order of 2.66 million tonnes with 35 to 42% CaO of which one million tonnes are of cement grade.

Shell limestone/lime shell/ Coralline limestone/Kankar

In Gulf of Mannar on Rameswaram Island about 2.03 million tonnes of very pure quality coral limestone have been estimated.

A total of 1.68 million tonnes of shell limestone occurs near Kovalam, Kanyakumari, Lipuram, Vattakottai and Kanagappapuram in Agastheeswaram Taluk of Kanyakumari District. About 81,300 tonnes of shell limestone occur north of Rameswaram.

Lime shells of about 30,000 tonnes with CaO 54.45% are estimated from Marakkanam area in Villupuram District and about 50,000 tonnes of lime shell are estimated in Pulicat lake area of Thiruvallur District. Tufaceous limestone and kankar of about 23.04 million tonnes occurs near Vijayapatti in Tirunelveli District. In Thanjavur District on the Grand Anicut Canal cutting between Kuruvadipatti and Podur and also in the neighbourhood of Tirumalai Samudram, good quality kankar with CaO 48.43 to 52.72% occurs for about 0.5million tonnes. About 0.3 million tonnes of kankar with CaO content 32 to 47.39% occurs over Tirukkalikunram, Sembakkam and Kalathur in Thiruvallur District and about 0.4 million tonnes of kankar occurs northeast of Dasampatti in Dharmapuri District.

Magnesite

In Tamil Nadu the most prominent deposit of magnesite is located on Chalk Hills, Salem District spreads 17 sq km. Other minor occurrences are located in other areas in Salem District and parts of Dharmapuri, Namakkal, Erode, Coimbatore and Tiruvannamalai Districts.

Magnesite on Chalk Hills occurs as criss-cross veins traversing dunite / peridotite (Aiyengar and Krishnan, 1943). The veins vary in length from a fraction of a metre to 100's of metre and thickness from less than a centimetre to as much as 1.5 m. The total reserves in the Chalk Hills are estimated at 44 million tonnes. However, only 20 to 25 % of the reserves are of grade -I with <2.5% silica. Generally MgO varies from 43 -46.5 % while SiO_2 varies from 2 - 8 % and exceeds 10 % at some places (Sundaram et al, 1985).

Minor occurrences are reported from Chettipatti, Jalakandapuram, Rajampalayam, Sirappalli, Siranganur and Vimanayakanur in Salem District. About 0.1 million tonnes of magnesite is estimated from Thengumarahada in Moyar valley in Nilgiri District. About 84,285 tonnes of magnesite is inferred near Torappadi in Tiruvannamalai District. Minor occurrences of magnesite are noticed near Vanaripatti, Tirupangilli between Valasiramani and Andipatti in Tiruchirapalli District and Oddanur, Solavapalayam, south of Bhavanisagar and around Doddakombaihalla in Gobichettipalaiyam Taluk in Erode District. Near Kanjanur within the Samalpatti pluton in Dharmapuri District, magnesite is mined to limited extent.

Mica

In Erode District, light ruby coloured mica varying in size from 12.5 to 25 cm, was reported 4.8 km east of Idappadi and 0.8 km southwest of Kurumbapatti. Mica bearing pegmatites were reported from a few other localities also.

In Kanyakumari District, irregular pockets of phlogopite were traced near the contact of charnockite and leptynite close to Tiruvidamkode and Eraniel. They are not of economic importance. Small occurrences have been traced near Vilavancode, Appiyode and Neyyur.

In Nilgiri District there are old workings for mica around Gudalur and Cherambadi. Mica of 15 to 20 cm across has been reported from pegmatites near Bokkapuram and Chembanattam.

In Tiruchirapalli District, mica-bearing pegmatites were traced near Kadavur. In two pegmatite veins, muscovite sheets upto 3 to 7 cm width were recovered. A reserve of 0.002 million tonnes of muscovite upto a depth of 10.6m in the Sukkampatti is estimated.

Mineral Pigment (Ochre and red oxide)

Near Sivaganga Town, Sivaganga District, buff, mauve, yellow and pink shales are exposed. A total of 2.83 million tonnes of yellow shale and similar quantity of other coloured varieties are estimated. About 15 to 30 cm thick red oxide c appings occur over the Upper Gondwanas, southwest of Sunkuvarchatram around Vallam, Mettupalaiyam and Eraiyur in Thiruvallur District. In Tiruchirapalli District, red and yellow shales occur in the Sengirai Reserve Forest area.

Moulding and Glass sands

A stretch of white sands along the eastern coast occurs near Cheyur. The indicated reserves upto a depth of 5 m are of the order of 0.82 million tonnes. Recent work has brought to light, a number of sand stretches along the coast from near Chennai to Pondicherry. The sand analyses over 95% SiO_2 1 to 1.5% Fe_2O_3 and upto 3% Al_2O_3. The grain size ranges mostly between 40 and 120 mesh. Reserve in selected areas is estimated at the order of 7.5 million tonnes by the Department of Geology and Mining, Government of Tamil Nadu. In addition, huge quantity of white sand occurs below the lignite seam in Neyveli mines, which may be suitable for manufacture of Hi-tech glass products like float glass etc.

Quartz (Rock crystals)

In Salem District, good grade vein quartz was reported near Omayanur, Siddharkovil and Kanagiri. Quartz veins, which are traced near Dasanur and Aranganur are free from staining. The quartz vein occurrences near Singliyamkombai, Ishwaramurthi-palaiyam and Siliyampatti may yield good quality quartz.

Reh salt / Soil and Common Salt

Salts of sodium sulphite and sodium corbonate are reported from Tiruvamur and Asanur, Cuddalore District, Viramur and Kachirapalaiyam of Villupuram District. The yield of salts from the above localities is estimated to be of the order of 1500 tonnes.

At several places, along the coastal areas common salt is produced in the backwater from salt pans by evaporation under the sun.

Sillimanite

The State Department of Geology, Government of Tamil Nadu, traces sillimanite occurrences at Kadavur and Idaiyappatti, Tiruchirapalli District and computed a reserve of 515 tonnes upto a depth of 3 m. Minor occurrences are known from Vellore District.

Steatite

In several localities in Salem District including Chinnappanapatti, between Taramangalam and Toppai Ar River over an area of 250 sq km, Omalur, Aranganur, Komaliyur and Marakkotai, steatite occurrence is noticed.

The occurrences in the northern part of Walajah Taluk in Vellore District are worked in a small way for making utensils. Isolated outcrops of steatite also occur east of Iswaramurtipalayam, south of Singiliankombai and north of Tamamapatti (all in Salem District).

Vermiculite

In Vellore District, the State Department of Geology, Government of Tamil Nadu investigated a vermiculite deposit near Elavampatti. The mineral, which occurs as pods and lenses shows an exfoliation index upto 15 times the original volume when heated to 850ΥC. A total reserve of 1.93 lakh tonnes has been estimated upto a depth of 9 m. Near Sevattur, vermiculite occurs in the northern part of a pyroxenite band, traversed by carbonatite. The State Department of Geology, Government of Tamil Nadu, estimated a reserve of 1,32,086 tonnes of vermiculite upto a depth of 9 metre in 162.6 hectares area.

Hydrobiotite occurring in pegmatites near Sukkampatti and Rajapatti in Manapparai taluk, Tiruchirapalli District was investigated and an aggregate reserve of 51 tonnes estimated upto a depth of 7 to 10 metres. The mineral on heating to 850ΥC, expands 7-14 times its original volume.

In Tirunelveli District, the State Department of Geology prospected a vermiculite occurrence near Singathakurichi and estimated a reserve of 10 tonnes upto a depth of 7.3 metres.

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LOCALITY INDEX

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Adirampatnam	10	20	79	23
Alambadi	12	07	78	39
Alangadu	11	48	78	31
Alangayam	12	38	78	46
Alangulam	09	53	77	58
Allanganathan	11	11	78	15
Anaipadi	11	06	78	57
Anandavadi	11	11	79	11
Andipatti	09	56	77	38
Andur	11	15	79	02
Annadanapatti	11	28	77	54
Appiyode	08	15	77	12
Aranganur	11	48	78	00
Aranthangi	10	10	79	01
Araokkonam	13	05	79	40
Ariyurnadu	11	18	78	22
Arumanallur	08	18	77	24
Asanur	11	38	79	11
Athangarai	08	15	77	50
Attur	11	35	78	27
Attur Valley	11	35	78	36
Avispakkam	11	52	79	48
Avudair kovil	10	04	79	02
Ayyampalaiyam	10	34	78	10
Ayyanapuram	08	52	78	09
Bahur	11	48	79	45
Bargur	11	49	77	33
Battadapuram	11	14	76	57
Berijam Fort-Hamilton	10	11	77	25
Bethal	11	19	76	38
Bevanur	12	04	77	46
Bhavani	11	26	77	41
Bhavanisagar	11	29	77	07
Bisanattam	12	01	78	15
Bodinayakkanur	10	00	77	21

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Bokkapuram	11	32	76	39
Budamangalam	12	23	79	14
Chalk Hills	11	43	78	10
Chembanattam	11	34	76	41
Chennimalai	11	10	77	36
Cherambadi	11	31	76	17
Chettipatti	11	33	77	46
Cheyur	12	21	80	00
Chinappanapatti	11	38	77	57
Chinnayapuram	09	29	77	54
Chittali	11	15	78	59
Coimbatore	11	00	76	50
Colachal	08	11	77	16
Dalmiapuram	10	58	78	57
Dasanur	11	53	78	01
Devala	11	28	76	23
Devannagavundanur	11	30	77	50
Devarmalai	10	44	78	10
Dharmapuri	12	02	78	29
Dimbam	11	38	77	08
Doddakombaihalla	11	31	77	02
Ebbari	12	39	78	12
Edapalaiyam	12	55	79	53
Elagiri	12	33	78	35
Elaiyarpatti	09	47	78	05
Elavampatti	12	24	78	32
Eraiyur	12	53	79	57
Eraniel	08	12	77	19
Ganguvarpatti	10	10	77	42
Gejjalampatti	10	42	78	03
Gingee	12	15	79	25
Godepalaiyam	11	27	77	09
Godumalai	11	41	78	20
Govanur	11	10	76	54
Govindampalaiyam	11	31	78	50
Gudalur	11	31	76	29
Gudiyattam	12	57	78	53

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Harur	12	03	78	41
Hogenckal	12	04	77	46
Idaiyappati	10	35	78	13
Idappadi	11	35	77	50
Ilada	11	29	76	54
Ishwaramurthipalaiyam	11	34	78	24
Jakkarpalaiyam	10	47	77	09
Jakkeri	12	31	77	48
Jalakandapuram	11	42	77	53
Jayamkondacholapuram	11	14	79	24
Josiyar Alangulam	09	53	77	53
Kachirapalaiyam	11	47	78	52
Kadavanur	11	43	79	42
Kadavur	10	36	78	12
Kalakkadu Hills	08	32	77	34
Kalambedu	13	00	79	50
Kallai	11	19	79	05
Kallakudi	10	56	78	55
Kallamedu	11	11	79	08
Kallampatti	10	45	78	04
Kallar	08	57	78	13
Kalpadi	11	30	78	53
Kalpalaiyam	10	58	78	47
Kamalapuram	10	44	79	35
Kambalipatti	10	06	78	20
Kambam	09	44	77	17
Kambbamettur	09	45	77	13
Kanagappapuram	08	09	77	35
Kanagiri	11	33	78	01
Kanchi Road	12	23	78	58
Kanchipuram	12	50	79	42
Kangayam	11	00	77	34
Kanjamalai	11	37	78	04
Kanjanur	12	16	78	28
Kannanthangal	12	58	79	49
Kannukaranur	10	33	77	53
Kannur	12	59	79	51

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Kanyakumari	08	05	77	33
Karadikuttam	10	27	77	27
Karai	11	08	78	53
Karaikal	10	35	79	50
Karamadai	11	15	76	57
Karappadi	11	26	77	19
Kargudi	11	09	78	26
Karungalagudi	10	09	78	22
Karungalpatti	11	16	78	01
Karuveppampatti	11	27	77	55
Kasrasur	11	59	79	44
Kattanpatti	10	48	77	09
Kattanumalai	11	12	76	56
Kavakkarapatti	11	07	78	18
Kavuthimalai	12	18	79	01
Kayathar	08	57	77	46
Kelacheri	13	02	79	51
Kerkombai	11	28	76	52
Kil Avinjipattu	11	51	79	47
Kilakarai	09	14	78	47
Kilpaluvur	11	02	78	04
Kiranur	10	47	78	17
Kodiyampalaiyam	11	23	78	49
Kolikalnattam	11	26	77	55
Komaliyur	11	46	78	02
Kommanthangal	12	58	79	50
Konal Ar	10	11	77	23
Koratti	12	15	78	33
Kotagiri	11	25	76	52
Kovalam	08	05	77	32
Kovalong	12	47	80	15
Kovilkalappal	10	33	79	33
Krishnagiri	12	32	78	13
Kukkal	10	18	77	22
Kulanayakkanpatti	10	37	77	08
Kulumur	11	19	79	09
Kumalampattu	12	09	79	48

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Kunnam	12	05	79	40
Kunnamalai	11	13	77	58
Kuppamatti	11	37	77	54
Kurichchi	11	34	77	42
Kurinjankulam	09	14	77	41
Kurumbapatti	11	35	77	52
Kuttankuli	08	13	77	47
Lipuram	08	07	77	33
Madukkarai	10	54	76	58
Mahadevi	11	09	78	24
Malamutti	10	36	78	40
Malapalaiyam	11	27	77	47
Malathangi	11	54	78	36
Mallanayakanpalayam	11	26	77	10
Mamandur	12	00	79	00
Mamarathupatti	10	45	78	15
Manakkudi	08	07	77	13
Manamudu	11	58	78	23
Manapparai	10	36	78	25
Manavalakurichi	08	10	77	15
Manguli	11	10	76	54
Manmalai	11	49	78	51
Mannargudi	10	41	77	30
Mappadu	13	02	79	52
Marakkanam	12	12	79	50
Marakkotai	11	49	78	00
Maranur	11	28	77	12
Marudamalai	11	02	76	51
Maruvathur	11	15	78	57
Mathur	12	53	79	56
Mattur	11	18	79	13
Mayiladudurai	11	06	79	39
Mayilkalpalaiyam	11	18	77	50
Melur	10	00	78	20
Mettupalaiyam	12	53	79	55
Mettupalayam	11	18	76	46
Mettur	11	47	77	47

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Midalam	08	11	77	13
Mimisal	09	55	79	08
Minjur	13	17	80	16
Mottaiyanur	11	29	77	48
Muddampalaiyam	11	12	76	58
Mulakkattanur	11	29	77	49
Muttanchetty	11	07	78	19
Nadandai	11	12	77	58
Nagamalai	09	56	78	03
Nainarmalai	11	20	78	13
Namakkal	11	13	78	10
Nambiyar	08	15	77	43
Nangavalli	11	46	77	54
Narayanapuram	12	23	79	58
Narthamalai	12	36	78	31
Navaladi	08	15	77	50
Nedumanur	11	51	78	54
Nettappakkam	11	52	79	38
Nevadipallam	10	09	77	20
Neykulam	11	03	78	51
Neykulam	11	02	78	50
Neyveli	11	33	79	29
Neyyur	08	14	77	18
Nonankuppam	11	53	79	48
Oalaippadi	11	20	79	06
Odaiyapatti	10	48	78	15
Oddanchatram	10	29	77	45
Oddanur	11	29	77	11
Omalur	11	45	78	03
Omayanur	11	44	78	05
Oravappatti	11	46	77	49
Padiyur	11	04	77	30
Paithur	11	32	78	35
Pakkanadu	11	40	77	50
Pakkili	12	14	78	01
Palaiyam	10	43	78	08
Palavanattam	09	33	78	00

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Pallakkapalaiyam	11	27	77	46
Pallavaram	12	57	80	11
Panaiyadikuppam	11	51	79	39
Pandalkudi	09	24	78	05
Pandalur	11	29	76	20
Pandapalli	09	19	77	34
Panruti	11	46	79	35
Paravay	11	17	79	12
Parson's Valley	11	23	76	37
Pattukidapattanam	09	52	79	07
Perambalur	11	14	78	51
Periakurukkai	11	02	79	50
Periaswamipuram	09	03	78	17
Periyakurukkai	11	02	78	50
Periyapattanam	09	16	78	64
Pillaitottam	11	56	79	47
Pillisulinettu	10	09	77	23
Ponneri	13	20	88	12
Poykkunam	11	52	78	53
Pudukottaoi	10	22	78	48
Pudupalaiyam	12	22	78	53
Pudupattanam	09	41	78	59
Pudupuram	11	10	79	51
Pudur	10	37	77	09
Puduvalavu	11	59	78	38
Pulangkurchi	10	16	78	35
Pullambadi	10	56	78	55
Punjai puliyampatti	11	21	77	10
Pusaripatti	10	40	77	07
Puvandhi	09	51	78	17
Rajapalayam	09	27	77	33
Rajapatti	10	31	78	24
Ramadevam	11	14	77	59
Ramayyanpatti	08	46	77	42
Rameswaram	09	17	79	19
Rasipuram	11	14	78	51
Rayarpatti	10	08	78	20

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Sakkaraikkottai	10	47	78	14
Salaippalaiyam	11	20	77	56
Samalpatti	12	19	78	29
Samipuliyur	10	46	78	17
Sankari	11	29	77	52
Sattakulam	11	27	78	55
Sattarai	13	03	79	51
Saundaricholapuram	11	23	79	16
Sekkadipatti	10	11	78	26
Seliamedu	11	48	79	47
Selurnadu	11	13	78	20
Sengirai	10	15	78	50
Sevattur	12	26	78	31
Shevroy Hills	11	46	78	13
Sholingur	13	00	79	26
Sikkathambur	11	00	78	31
Siliyampatti	11	34	78	31
Singathakurichi	08	47	77	05
Singliyamkombai	11	32	78	25
Sirappalli	11	12	77	57
Siruganpur	11	10	78	56
Sirukanbur	11	10	78	56
Sittampundi	11	16	77	50
Sittampundi	11	14	77	54
Sittilingi	11	55	78	37
Sivaganga	09	51	78	29
Sivamalai	11	02	77	02
Sivanmalai	11	03	77	36
Solavanur	11	25	77	10
Somagiri	10	10	78	28
Sriperumbudur	12	58	79	57
Sriranganur	11	44	77	57
Sukkampatti	12	36	78	30
Sunkuvar Chatram	12	38	79	53
Suryagaddi	11	51	78	35
Tadakarakonam	08	20	77	25
Talaiyuthu	08	48	77	43

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Talankunam	12	25	79	16
Talavadi	11	48	77	01
Tamarakkarai	11	46	77	34
Tamamapatti	11	27	78	29
Tappay	10	50	78	55
Taramangalam	11	42	77	58
Tarani	11	06	78	52
Taruvaikkulam	08	54	78	10
Tattakarai	11	51	77	33
Taylors Hill	11	26	76	51
Terani	11	06	78	52
Tettampatti	10	14	78	15
Thachankurichchi	10	57	78	49
Thamaraipundi	11	20	79	15
Thengumarahada	10	58	77	40
Thenmudianur	11	42	79	02
Thirthamalai	12	05	78	40
Thirukovilur	11	58	79	12
Thiruvadani	09	47	78	55
Thiruvakarrai	12	01	79	40
Tindivanan	11	36	79	36
Tinnanurnadu	11	14	78	20
Tiruchengode	11	23	77	54
Tiruchirapalli	10	48	78	42
Tirumalai Samudram	10	44	79	01
Tirumullaivasal	11	14	79	45
Tirunelveli	08	45	77	42
Tirupangilli	10	56	78	39
Tirupattur	11	02	78	47
Tiruttani	13	11	79	37
Tiruvakkarai	12	02	79	40
Tiruvamur	11	06	79	29
Tiruvanmamalai	12	14	79	04
Tiruvanmiyur	12	52	80	16
Tiruvarur	10	47	79	39
Tiruvidamkode	08	15	77	18
Togamalai	10	44	78	24
Torappadi	12	19	78	53

Name of the place	Latitude (N)		Longitude (E)	
	Deg.	Min.	Deg.	Min.
Tranquebar	11	01	79	51
Turaiyur	11	09	78	36
Upper Bhavani	11	41	77	32
Usilampatti	09	58	77	47
Uttangarai	12	16	78	33
Uttattur	11	04	78	52
Uvari	08	17	77	54
Vadavattur	11	06	78	17
Vaippar	09	02	78	15
Vairamangalam	11	28	77	37
Vaiyampatti	10	33	78	18
Vaiyupur	12	58	79	58
Vakkalipatti	11	25	77	55
Valasiramani	11	08	78	22
Valinokkam	09	10	78	58
Vallam	12	54	79	46
Vallam	12	34	79	56
Vanjinagaram	10	08	78	21
Vanjipalaiyam	10	54	77	28
Varanalpalayam	11	28	77	48
Varugapadi	11	09	78	54
Vattakottai	08	08	77	34
Vattanam	09	47	79	04
Vedaranniyam	10	22	79	51
Vedasandur	10	32	77	57
Vediappanmalai	12	18	79	02
Velampatti	12	05	78	27
Velavanchinadu	11	12	78	20
Vellore	12	55	79	08
Vembar Naripaiyur	09	08	78	26
Veppalodai	08	58	78	11
Veppanapalli	12	42	78	11
Vijayapatti	08	11	77	45
Vilavancode	08	20	77	11
Villiyanpampatti	11	09	78	06
Vimanayakanur	11	10	78	14
Viramur	12	01	79	25
Viranam	11	51	79	39
Yellikaradu	11	47	77	48

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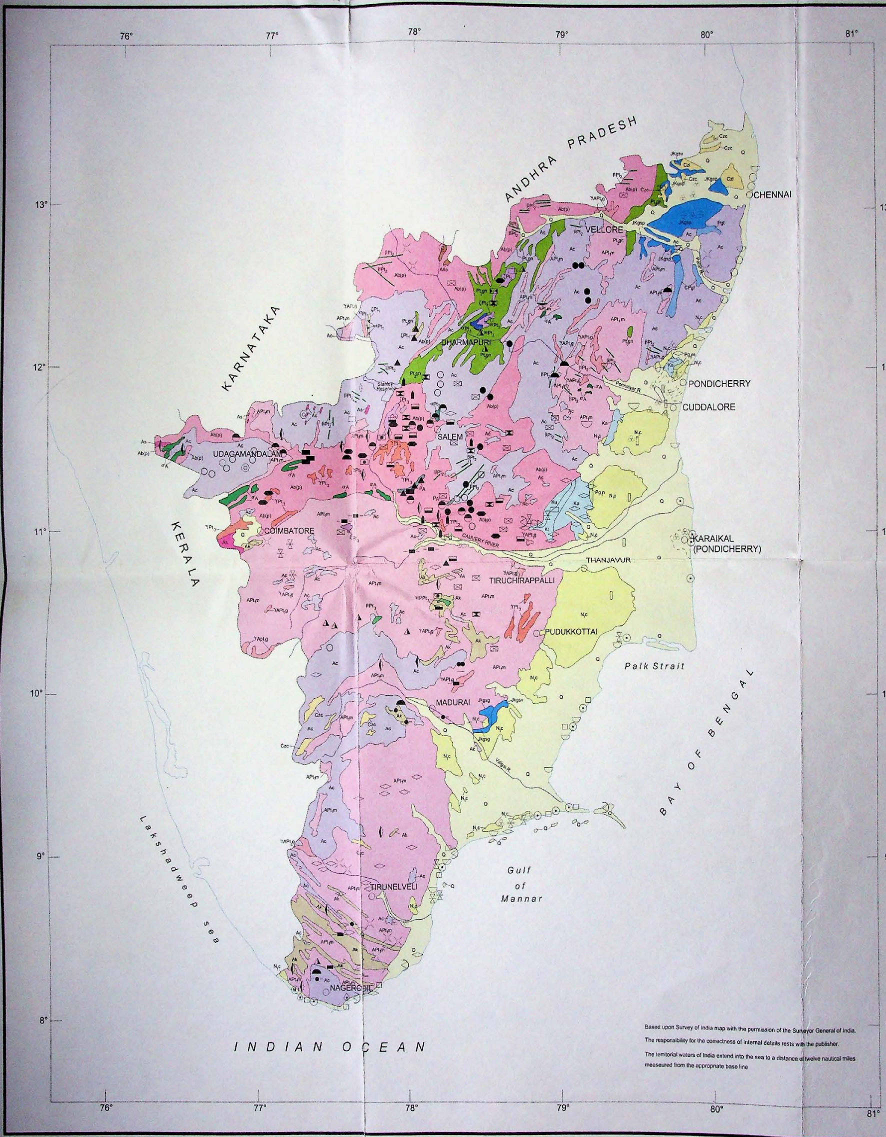

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81°

GEOLOGICAL AND MINERAL MAP OF TAMIL NADU AND PONDICHERRY

2006

SCALE 1: 2,000,000

Km 40 20 0 40 80 Km

13°

LEGEND

Symbol	Description	Formation	Group	Age	Period / Era
Q	Fluvial, fluvio - marine, aeolian and marine sediment			Pleistocene to Recent	QUATERNARY / CAINOZOIC
Czl Czc	Laterite; calcareous gritty sandstone and clay				CAINOZOIC
N_1c N_1p	Sandstone and clay	Cuddalore Formation (N_1c)/ Panamparai Formation (N_1P)		Mio - Pliocene	TERTIARY / CAINOZOIC
Pg_1n Pg_1m	Limestone with shale / clay / siltstone	Niniyur Formation (Pg_1n) / Manaveli Formation (Pg_1m)		Palaeocene	TERTIARY / CAINOZOIC
K	Sandstone with limestone and shale (Ka) / with shell limestone, clay & conglomerate (Kt), clay with limestone bands, conglomerate (Ku)		Ariyalur Group Trichinopaly Group Uttatur Group	Cretaceous	MESOZOIC
Jkg	Shale, sandstone, conglomerate	Satyavedu Formation (JKgsv) / Sriperumbudur Formation (JKgsp) / Sivaganga Formation (JKgsg)	Upper Gondwana (Gondwanas)	Lower Cretaceous	MESOZOIC
CPgt	Boulder bed, shale and conglomerate	Talchir Formation	Lower Gondwana (Gondwanas)	Upper Carboniferous to Lower Permian	PALAEOZOIC
γPt_3	Granite		Younger Granite	390 - 550 Ma	PROTEROZOIC to PALAEOZOIC
νPt_3 ρPt_3	Gabbro(ν) anorthosite (ρ)		Ultrabasic / basics (younger) ($^{\nu/\rho}Pt_3$)	700 Ma	NEO PROTEROZOIC
ωPt_3 σPt_3 ζPt_3 ξPt_3 Pt_3gn	Carbonatite (ω),ultrabasic complex (σ), alkaline complex (ζ), alkaline rocks (ξ) epidote hornblende gneiss (Pt_3gn)		Alkali complex (younger) (ζPt_3)	700 - 900 Ma	NEO PROTEROZOIC
$/\beta Pt_2$	Basic dykes		Basic intrusives	1600 - 2100 Ma	MESO PROTEROZOIC
ωPt_1 ζPt_1 σPt_1	Carbonatite (ω) , alkaline dykes and syenite complex (ζ), ultrabasic complex (σ)		Alkali complex (older) (ζPt_1)	1900 - 2300 Ma	PALAEO PROTEROZOIC
(a) APtm (b) γAPtg	(a)Grey migmatite / pink migmatite, pink augen gneiss, hornblende gneiss, hornblende-biotite gneiss, garnetiferous quartzofeldspathic gneiss, garnet-biotite gneiss (b) Older granite / granitoids		Migmatite complex (Peninsular Gneissic Complex II)	2200 - 2500 Ma	LATE ARCHAEAN to PROTEROZOIC
Ac	Basic and ultrabasic rocks, magnetite quartzite pyroxene granulite, charnockite		Charnockite Group	2600 Ma	LATE ARCHAEAN
Ak	Calc-granulite, limestone, quartzite garnet-sillimanite-graphite gneiss		Khondalite Group		ARCHAEAN
Ako	Quartzofeldspathic rock, amphibolite banded ferruginous quartzite		Kolar Group	2900 Ma	ARCHAEAN
Ab(p)	Pink migmatite, granitoid gneiss fissile hornblende gneiss		Peninsular Gneissic Complex I (Bhavani Group)	3000 Ma	ARCHAEAN
	Ultramafic / mafic, ultrabasic rock		Layered ultramafic, mafic, ultrabasic complex	3000 - 3100 Ma	ARCHAEAN
	Amphibolite, basic and ultrabasic rocks ... corundum, mica schist		Satyamangalam ...	3200 Ma	ARCHAEAN

12°

11°

10°

9°

MINERAL INDEX

- Apatite
- Asbestos
- Barytes
- Base metals / Polymetalic sulphides
- Bauxite
- Beryl
- Celestite
- Clay
- Chromite
- Columbite - Tantannite
- Construction materials
- Corundum
- Feldspar
- Garnet
- Gemstone
- Gold
- Graphite
- Gypsum
- Ilmenite
- Iron Ore
- Kankar
- Lignite
- Limestone
- Magnesite
- Mica
- Molybdenum
- Monazite, Zircon, Rutile
- Moulding and glass sands
- Nickel Ore
- Ochre
- Rock Phosphate
- Quartz (Rock crystals)
- Reh salt / soil
- Salt (Common salt)
- Shell limestone

Symbol	Lithology	Group / Unit	Age	Era
γPt_3	Granite	Younger Granite	390 - 550 Ma	PROTEROZOIC to PALAEOZOIC
νPt_3 ρPt_3	Gabbro(ν) anorthosite (ρ)	Ultrabasic / basics (younger) ($^{\nu\rho}Pt_3$)	700 Ma	NEO PROTEROZOIC
ωPt_3 σPt_3 ζPt_3 ξPt_3 Pt_3gn	Carbonatite (ω), ultrabasic complex (σ), alkaline complex (ζ), alkaline rocks (ξ) epidote hornblende gneiss (Pt_3gn)	Alkali complex (younger) (ζPt_3)	700 - 900 Ma	
βPt_2	Basic dykes	Basic intrusives	1600 - 2100 Ma	MESO PROTEROZOIC
ωPt_1 ζPt_1 σPt_1	Carbonatite (ω), alkaline dykes and syenite complex (ζ), ultrabasic complex (σ)	Alkali complex (older) (ζPt_1)	1900 - 2300 Ma	PALAEO PROTEROZOIC
(a) APt_1m (b) γAPt_1g	(a) Grey migmatite / pink migmatite, pink augen gneiss, hornblende gneiss, hornblende-biotite gneiss, garnetiferous quartzofeldspathic gneiss, garnet-biotite gneiss (b) Older granite / granitoids	Migmatite complex (Peninsular Gneissic Complex II)	2200 - 2500 Ma	LATE ARCHAEAN to PROTEROZOIC
Ac	Basic and ultrabasic rocks, magnetite quartzite pyroxene granulite, charnockite	Charnockite Group	2600 Ma	LATE ARCHAEAN
Ak	Calc-granulite, limestone, quartzite garnet-sillimanite-graphite gneiss	Khondalite Group		ARCHAEAN
Ako	Quartzofeldspathic rock, amphibolite banded ferruginous quartzite	Kolar Group	2900 Ma	
Ab(p)	Pink migmatite, granitoid gneiss fissile hornblende gneiss	Peninsular Gneissic Complex I (Bhavani Group)	3000 Ma	
σA PA	Ultramafic / mafic, ultrabasic rock	Layered ultramafic, mafic, ultrabasic complex	3000 - 3100 Ma	
As	Amphibolite, basic and ultrabasic rocks sillimanite-kyanite- corundum- mica schist fuchsite- kyanite ferruginous quartzite	Satyamangalam Group	3200 Ma	

Graphite
Gypsum
Ilmenite
Iron Ore
Kankar
Lignite
Limestone
Magnesite
Mica
Molybdenum
Monazite, Zircon, Rutile
Moulding and glass sands
Nickel Ore
Ochre
Rock Phosphate
Quartz (Rock crystals)
Reh salt / soil
Salt (Common salt)
Shell limestone
Sillimanite
Steatite
Tin - Tungsten
Vermiculite

10°
9°
8°
81°

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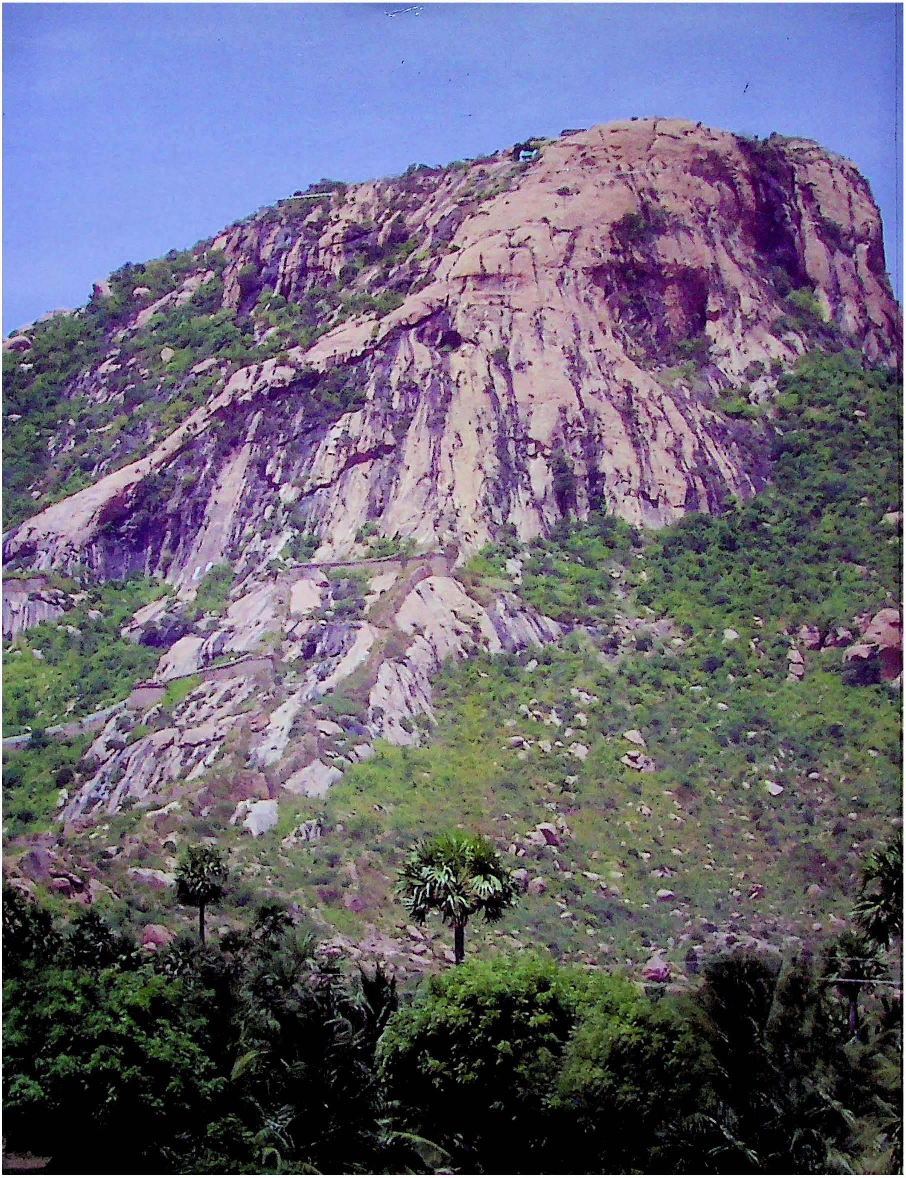
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